AIDS

TO

SURGICAL ANATOMY.

BY

EUGENE S. YONGE, M.B.,

MASTER IN SURGERY UNIV. EDIN.; SENIOR MEDALLIST IN MENTAL DISEASES UNIV. EDIN.; LATE HOUSE-SURGEON MANCHESTER SOUTHERN AND MATERNITY HOSPITAL; ASSISTANT MEDICAL OFFICER MANCHESTER HOSPITAL FOR CONSUMPTION AND DISEASES OF THE CHEST.

NEW YORK:
WILLIAM WOOD & COMPANY.
1895.

PREFACE.

An attempt has been made in the following pages to condense and systematize the principal facts of Surgical Anatomy. As the name implies, the work is intended to be used as an aid to—not as a substitute for—the standard works on the subject, and it should be read either concurrently with a text-book on Surgical Anatomy, or after the student has perused such a manual.

I am much indebted to the works of Gray, Treves, McLachlan, Holden, and Quain for the valuable assistance I have received whilst preparing this compilation.

My warmest thanks are due to Mr. J. P. Hall for the skill and trouble he has expended in the execution of the illustrations, and I must express my acknowledgments to Mr. R. T. Hughes for assistance in revising the proofs.

E. S. Y.

75, Burlington Street,
Manchester.

CONTENTS.

AIDS TO SURGICAL ANATOMY

CHAPTER I.

THE HEAD AND NECK.

The Scalp.

The soft parts covering the skull may be divided into five layers: (1) The skin, which is very thick, very vascular, and contains many sebaceous glands, hence the prevalence of **wens** in this situation. (2) The subcutaneous tissue. (3) The occipito-frontalis muscle and aponeurosis. (4) The subaponeurotic tissue, which is extremely lax, and is known as the 'dangerous area.' The layers above can be freely moved upon it, and in the time-honoured operation of 'scalping,' the scalp separates through this layer; from its laxity, also, suppuration tends to spread in all directions, even from occiput to supra-orbital ridges. (5) The pericranium. (6) The bone and (7) the dura mater. The pericranium differs from the periosteum in the following particulars: The pericranium is easily stripped off, the periosteum is not; the pericranium, when stripped off, is not usually followed by necrosis of the cranial bones by reason of the blood-supply to the bones derived from the dura mater, but when periosteum is stripped from a bone, necrosis usually does occur. The pericranium, as a rule, obstinately refuses to form new bone, whilst periosteum readily performs that function.

Wounds of the Scalp (1) are particularly dangerous because of the intimate connection between the structures internal to the skull and those external to it, and the peculiar arrangement of the bloodvessels of the part by means of which the vessels of the skin are brought into more or less direct communication with the intracranial vessels. (2) They do not gape unless the occipito-frontalis muscle or aponeurosis be involved. (3) They appear like incised wounds, even when contused, because of the density of the scalp. (4) They bleed freely, but at the same time heal kindly even when extensive flaps are separated—all this by reason of the abundant vascularity of the part.

One peculiar source of danger in wounds or diseases of the scalp tissues is brought about by the existence of—

Emissary Veins.—These vessels establish communications between the sinuses within the skull and the veins external to it, hence erysipelas or other septic diseases affecting the scalp may lead to meningitis, thrombosis of the sinuses, and other grave intracranial troubles.

Table of Emissary Veins (Gray).

1. **A vein** passing through the mastoid foramen	connecting	lateral sinus with the posterior auricular (or an occipital) vein.
2. **A vein** (inconstant) passing through posterior condyloid foramen	,,	lateral sinus with deep veins of neck.
3. **A vein** passing through parietal foramen	,,	superior longitudinal sinus with veins of scalp.
4. **A plexus** of minute veins passing through anterior condyloid foramen	,,	occipital sinus with vertebral veins and deep veins of neck.
5. **Veins** passing through foramen ovale	,,	cavernous sinus with pterygoid and pharyngeal plexuses.
6. **Veins** passing through foramen lacerum medium	,,	the same parts.

7. **A vein** (inconstant)	connecting	cavernous sinus with pterygoid and pharyngeal plexuses.
8. **A plexus of veins** passing through carotid canal	"	cavernous sinus with internal jugular vein.

Abscesses of the Scalp region may be (*a*) above the aponeurosis of the occipito-frontalis, when they are insignificant in size on account of the density of the tissues; (*b*) beneath the aponeurosis, when they are more serious, since the laxity of the subaponeurotic tissue may allow of the whole scalp being undermined; they are, moreover, in this position slow to close up, after an external opening has been effected, on account of the constant contractions of the occipito-frontalis muscle; (*c*) subpericranial, in which case they would be limited to one cranial bone, since the pericranium dips into the sutures.

Abscesses in the Temporal Region have the two following peculiarities: (*a*) The pericranium in the temporal region being so extremely adherent to the bone, extravasations of pus (or blood) are practically unknown; and (*b*) the attachments of the temporal fascia prevent an abscess in the temporal fossa from opening upwards, so that the tendency is for the pus to spread into the neck or into the pterygoid or maxillary region.

Hæmatomata of the scalp may be found in the same positions, and obey the same laws. Cephal hæmatomata are subpericranial extravasations of blood found most frequently over one of the parietal bones, and due usually to pressure on the head at birth.

The Skull.

Necrosis of the Skull.—(1) Necrosis of the skull is frequently syphilitic, beginning as a gummatous periostitis; it is especially common about the forehead, but occurs also in the parietal bone; in the former situation it is, unfortunately, somewhat conspicuous, and has received the sobriquet of the 'mark of the beast.' As a rule, it is the external table which is affected.

(2) Necrosis is attended by special dangers: (*a*) com-

pression of the brain from a collection of pus beneath the bone; (*b*) suppurative phlebitis or thrombosis of the diplöic veins when the diplöe is involved; and (*c*) meningitis from extension of the morbid process to the meninges.

(3) When necrosis has taken place, exfoliation of dead bone is assisted by the growth of granulation tissue from the vascular diplöe.

Fracture of the Skull.—Certain morbid conditions of the skull may be mistaken for fracture. In **craniotabes**, a disease caused by hereditary syphilis or by rickets, the bone is thinned in patches, and these easily yield under slight pressure; such a case has been diagnosed as one of depressed fracture. Occasionally we find **congenital gaps** or **fissures** causing a similar error in diagnosis; these gaps are further of importance from the fact that protrusion of the brain (**encephalocele**) or its membranes (**meningocele**) may take place through them.

The Conditions resisting Fracture.—(*a*) *In the infant* fracture is rare, because of the resilient and yielding nature of the bones, so that they bulge rather than break; their wide separation and the interposition of soft structures also tend to resist fracture.

(*b*) *In the adult* the following conditions minimize the tendency to fracture; (1) the density and mobility of the scalp, (2) the dome-like form of the vault, (3) the liability of the force to be broken up among the segments of which the skull is composed, (4) the tendency of the sutures to interrupt the continuity of the fracturing force and the sutural membranes—present in early life—to act as buffers, (5) the elasticity of the cranial bones and the mobility of the head on the spine.

In old age the conditions minimizing the risk of fracture are reduced, the bones losing their elasticity and becoming more brittle, and the sutures anchylosing.

Fractures of the Vault are usually produced by direct violence, such as a blow from a heavy instrument. The fracture may assume a great variety of forms. Thus, it may be simple or compound, fissured or comminuted, depressed, raised, or punctured. A 'pond fracture' is one which is circular and comminuted, with lines of fracture radiating from the centre; it is usually effected by a round instrument, such as a life-preserver. The victims

of domestic differences not unfrequently suffer from a variety of fracture known as a 'gutter fracture,' which is readily produced by a poker.

Implication of Tables.—(*a*) The entire thickness of the skull is involved usually. (*b*) Sometimes the external table alone is implicated, as, for example, over the frontal sinuses. (*c*) The internal table has been fractured alone, or if not alone, (*d*) to a greater extent than the external table. The reasons for this are the thinner and more brittle character of the internal table, the fact that the diplöe breaks up and distributes the force over a larger area, the crushing together of the fragments of the outer table, causing a divergence of the particles of the inner table, and, lastly, the want of support to the inner table.

Fractures of the Base of the Skull are exceedingly serious because of their propinquity to the vital ganglia, and owing to the fact that they are usually compound.

The most frequent method of production is by the extension of a fissure from the vault. Sometimes they are caused by direct violence, as, for example, by a sharp instrument thrust upwards through the orbit. Occasionally a fall from a height on the buttocks or feet causes a fracture by indirect violence through the violent impact of the spinal column against the occipital condyles. A blow on the chin may also produce a fracture from indirect violence.

If the fracture occur, as it usually does, through the **middle fossa**, it takes a fairly definite course, and the **symptoms** resulting from this injury are explained by the direction taken by the fracture. Starting from the point struck, usually somewhere in the neighbourhood of the parietal eminence, the fissure travels down through the parietal bone and the squamous and petrous portions of the temporal bone, frequently implicating the internal auditory meatus, and injuring the facial and auditory nerves (hence the subsequent **facial paralysis** and **deafness**), or tearing the prolongation of arachnoid around these nerves in the meatus (hence the discharge of cerebro-spinal fluid from the ear, provided the mucous membrane of the tympanum and the tympanic membrane be torn). It eventually reaches the foramen lacerum medium, and from this it may pass across the body of the sphenoid through the pituitary fossa (leading to discharge of blood

into the pharynx if the muco-periosteum be torn, and perhaps subsequent **hæmatemesis**) to the foramen lacerum medium of the other side, and in rare cases still further.

When the fracture involves the **anterior fossa**, if the orbital roof be involved, there will be **subconjunctival ecchymosis.** If the cribriform plate of the ethmoid be fractured, there will be **bleeding** from the nose, and in rare cases, where the dura mater and arachnoid have both been torn, there will be a discharge of cerebro-spinal fluid from the nose.

In fractures of the **posterior fossa** there may be extravasation of blood about the nape of the neck.

The Brain and Membranes.

The Dura Mater (1) is tough, and therefore protective to the brain. (2) Is intimately adherent to the base of the skull, and but loosely attached to the vault ; in fact, its adherence is so slight in this situation that the vibration of a heavy blow may cause separation of the membrane without any fracture occurring. These facts explain the frequency of hæmorrhagic or purulent extravasations at the vertex, and their non-occurrence at the base. The result of these extravasations is as a rule compression of the brain, and the surgeon is assisted towards a diagnosis of the probable cause of a given case of compression by noticing the period at which the symptoms appear. Thus, if the symptoms are remarked at the time of the accident, the cause is probably compression by bone ; if a short time subsequent to the injury, blood ; and if some days or weeks after, pus. Hæmorrhagic extravasations are in the majority of cases due to rupture of the middle meningeal artery, the next most common source of the effused blood being the lateral sinus.

The Middle Meningeal Artery (1) arises from the internal maxillary artery, enters the skull through the foramen spinosum, and divides into two branches—an anterior and a posterior. The anterior branch runs upwards across the anterior inferior angle of the parietal bone, whilst the posterior branch runs backwards across the squamous bone. (2) The artery is frequently torn, and the branches oftener than the trunk, and, further, the anterior branch more frequently than the posterior. The reasons for this are—(*a*) the grooving of the bone by the

artery, (*b*) the embedding of the vessel in the bone, and (*c*) the liability of the region to fracture. (3) When the artery is ruptured, **trephining** is frequently necessary for the relief of compression.

The trephine is applied where the artery crosses the anterior inferior angle of the parietal bone—that is, $1\frac{1}{2}$ inches behind the external angular process, and $1\frac{3}{4}$ inches above the zygoma. The **structures cut through** are (i.) skin, (ii.) branches of the superficial temporal vessels and nerve, (iii.) the fascia continued downwards from the epicranial aponeurosis, (iv.) temporal fascia, temporal muscle and (deep) temporal vessels, (v.) pericranium.

Beneath the dura mater is the arachnoid, separated from it by the subdural space. The arachnoid is separated from the pia mater by the **subarachnoid space**, which contains the greater part of the cerebro-spinal fluid.

The chief **uses of the cerebro-spinal fluid** are the following : (1) It forms a 'water-bed' for the posterior two-thirds of the brain, containing important structures, and minimizes the effect of *contre coup;* that is to say, if a severe blow be struck, for example, on the vertex, the brain, instead of suffering any injury at the point of impact, is thrown against the base of the skull, and tends to be contused on the side opposite that to which the force was applied. The presence of the 'water-bed' helps to preserve the brain from injury in these cases. (2) It allows for increased intracranial blood pressure by being capable of being displaced through the foramen of Majendie.

Relation of the Brain to the Skull.

The lower level of the cerebral lobes is, in front, a straight line drawn across the forehead just above the eyebrows. At the sides, the lower level corresponds with a line drawn from the external angular process to the upper part of the external auditory meatus. Behind, the lower level corresponds to a line drawn from the meatus to the occipital protuberance.

Fissures.—1. *Longitudinal Fissure*, represented by a line running from the glabella at the root of the nose to the external occipital protuberance.

2. *Transverse Fissure*, represented by a line extending from the external occipital protuberance to the external auditory meatus.

3. *Fissure of Sylvius*, represented by a line extending from a point $1\frac{1}{4}$ inches behind the external angular process to $\frac{3}{4}$ inch below the most prominent part of the parietal eminence.

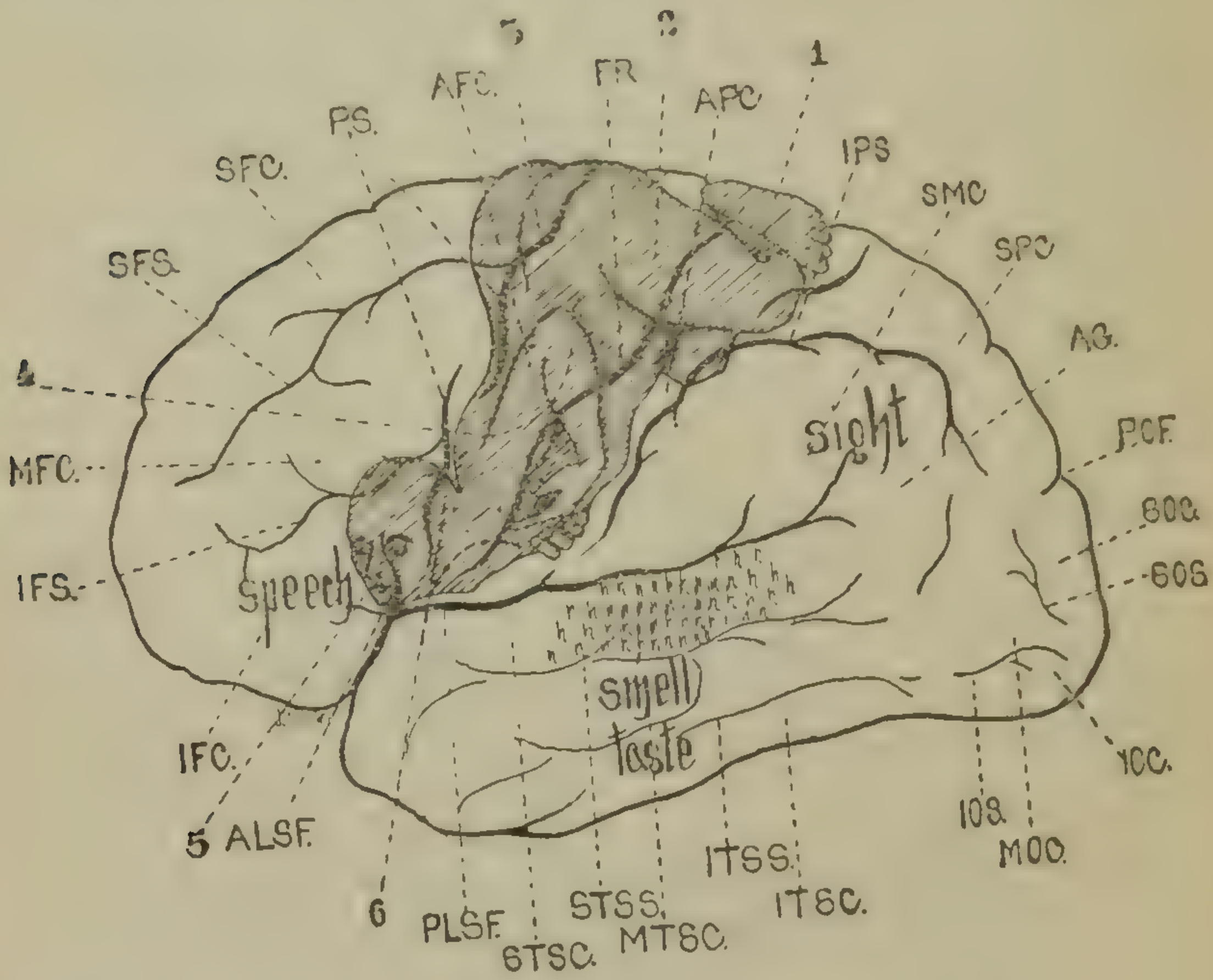

FIG. 1.—DIAGRAM SHOWING RELATIVE POSITIONS OF CORTICAL AREAS. 1. Foot area. 2. Leg area. 3. Area for swimming movements. 4. Arm area. 5. Speech area. 6. Face area.

This line is nearly 5 inches, therefore approximately:

(*a*) The anterior $\frac{1}{5}$ will represent the *main limb* of fissure.

(*b*) The posterior $\frac{1}{5}$ will represent the *horizontal limb* of fissure.

(*c*) A vertical $\frac{1}{5}$, drawn vertically upwards at junction of (*a*) and (*b*) will represent the *vertical limb* of fissure.

4. *Fissure of Rolando.*—(*a*) A point is taken $\frac{1}{2}$ inch behind the centre of a median line measured from glabella to occiput. (*b*) A line of which the axis is at an angle of 67° to this median line, running from the point above mentioned downwards and forwards for $3\frac{3}{4}$ inches, represents the fissure.

5. The *Parieto-Occipital Fissure* is represented by the last inch of a line formed by the horizontal limb of the Sylvian fissure continued on to the sagittal suture.

The **motor centres** are grouped about the fissure of Rolando. For their relative positions *vide* Fig. 1.

The Sinuses.—The *Superior Longitudinal Sinus* extends from the root of the nose to the occipital protuberance.

The *Lateral Sinus* extends from the occipital protuberance to the mastoid process, being somewhat arched. At a point $1\frac{1}{2}$ inches behind and $\frac{1}{2}$ inch above the level of the external auditory meatus the sinus turns abruptly downwards to reach the jugular foramen.

In **trephining**, avoid (1) the large vessels of the scalp and the middle meningeal artery, unless trephining over the artery is specially indicated; (2) the frontal sinus; (3) the sutures, which are frequently the points of exit of emissary veins, and, further, because the sutural membrane passes into the sutures and blends with the dura mater, giving rise, if lacerated, to a danger of **meningitis.** It is important to remember the varying thickness of the skull, and to allow the pin of the trephine to protrude no more than $\frac{1}{16}$ inch. The average thickness of the skull-cap is $\frac{1}{5}$ inch.

The Brain.

1. **Contusions** are most frequently situated on the under surface of the cerebrum and cerebellum. The basal collection of cerebro-spinal fluid, however, protects the medulla, pons, and interpeduncular space; hence bruising of these parts is the exception.

2. The **Blood Supply** is from the vertebral and internal carotid arteries, and shows the following noticeable points: (*a*) The supply is lavish. (*b*) The vessels become tortuous before entering the skull with the object, probably, of diminishing the force of the blood stream. (*c*) After entering the skull, the vessels anastomose by the

circle of Willis, and this has the effect of equally distributing the blood in the brain. (*d*) Supposing one carotid be occluded or tied, the remaining carotid and the two vertebrals are able to carry on the circulation, which is evenly balanced, as before. If both carotids be occluded, the vertebrals will be able to keep up the vascular supply if the two carotids are not closed at the same time, but a few weeks allowed to intervene, so that the vertebrals may have time to accommodate themselves to the increased work. A plugging of the smaller cerebral arteries is, of course, immediately followed by disastrous results. (*e*) On account of the great vascularity of the brain, wounds bleed freely, but are easily stanched. (*f*) The pulsations of the brain may be communicated to tumours and collections of fluid, and tracings of such pulsations show a heart and a respiratory curve.

The Orbit and the Eye.

The Orbit—*Diameters.*—Antero-posterior, $1\frac{3}{4}$ inches; horizontal (at base of orbit), $1\frac{1}{2}$ inches; vertical (also at base), $1\frac{1}{4}$ inches.

Boundaries.—The following bones enter into the formation of the cavity—Roof: Frontal and lesser wing of sphenoid. Floor: Superior maxillary, malar, and palate. Inner wall: Superior maxillary, lachrymal, ethmoid, and sphenoid. These three boundaries are all thin, especially the inner wall. Outer wall: Malar and sphenoid. This boundary is thicker than either of the remainder. The roof of the orbital cavity is in relation with the base of the skull; the floor is in relation with the antrum, the inner wall with the nasal fossa, and the outer wall with the temporal or zygomatic fossa. Hence, tumours may invade the orbit from any of these situations, sometimes making their way through bone, and at other times taking advantage of communicating foramina.

The Eyelids.—The **puncta lachrymalia** are two small openings situated on the margins of the lids about $\frac{1}{4}$ inch from the inner canthus. Normally, they lie in close contact with the conjunctiva of the globe, and readily absorb the tears: in some cases, however, of facial paralysis, and in cicatricial contraction of the lower lid, the punctum is everted, and the tears overflow and roll down the cheek, constituting **epiphora**.

The **lachrymal sac** is indicated in position by the tendo oculi, a little tense cord made evident at the inner angle of the eye when the eyelids are drawn outwards. The tendo oculi crosses the sac just above its middle; hence, in opening a **lachrymal abscess** the knife should be entered just below the tense cord above mentioned. It may also be noticed that a lachrymal abscess points in this situation.

The **tendon** of the superior oblique can be felt beneath the internal angular process.

Structure of the Eyelids.—The structures comprising the eyelids are, from without inwards, the following: (1) Skin, which is thin, and supported by lax subcutaneous tissue. For this reason it is freely movable, and may be drawn upon by the contraction of neighbouring cicatrices in such a manner as to produce eversion of the lid, **ectropion**, or—by forces acting in an opposite manner (inversion of the lid)—**entropion** may be produced. (2) The orbiculares muscle. This structure may be the seat of spasm or paralysis. (3) Loose connective tissue, which permits extensive infiltrations of blood or inflammatory material to take place. (4) The tendon of the levator palpebræ (in the upper lid only). (5) The tarsal cartilage. (6) The palpebral ligament. (7) The Meibomian glands, which may be the seat of retention cysts (**tarsal cysts**). (8) The conjunctiva, which, after lining the lids, is reflected on to the anterior part of the sclerotic and cornea. In the palpebral conjunctiva there is much adenoid tissue, and, in addition, mucous follicles and papillæ. **Granular lids**, or trachoma, is a condition in which these structures are hypertrophied. The irritation caused by granular lids leads frequently to **pannus**, a condition in which the anterior part of the cornea becomes vascularized.

The follicles of the eyelashes may inflame, constituting 'sty.'

Foreign bodies in the conjunctival sac is a common affection. If the body be of a caustic nature, such as lime, union may subsequently take place between the opposed conjunctival surfaces. The condition is known as **symblepharon.**

The Cornea—1. *Structure.*—The cornea consists of five layers: (1) Anterior epithelium. When this layer

has been removed by abrasion, if lead lotions are used as eyewashes, a deposit of lead salts is apt to take place on the floor of the abrasion. (2) Anterior elastic lamina of Bowman. (3) Corneal tissue proper, composed of elastic lamellæ, between which are anastomosing cell spaces. Along these canals pus may spread when suppuration has taken place, the appearance being known as **onyx**. (4) Descemet's membrane. (5) Posterior epithelium.

2. *Blood Supply.*—Except at the extreme periphery, where loops from the anterior ciliary arteries are present, there are no bloodvessels in the cornea, hence the tendency of this coat to inflame in the cachectic and ill-nourished. When inflamed, the cornea becomes opaque. In **interstitial keratitis** (a form of inflammation of the cornea to which congenital syphilitics are peculiarly liable) new vessels shoot into the hazy corneal tissue from the adjacent vessels, and produce the appearance known as a 'salmon patch.' Another form of vascularization of the cornea is seen in **pannus**, in which, however, the corneal tissue proper is not affected, the vessels passing over it immediately below the anterior epithelium. **Wounds** of the cornea heal kindly in spite of the deficient blood-supply.

3. *Nerve Supply* is lavish, and derived from the ciliary nerves. In **glaucoma** these nerves are pressed upon before their branches reach the cornea, and the consequence is anæsthesia of that coat.

The **Sclerotic** is dense and unyielding, hence the great pain felt in cases of increased intra-ocular tension. It possesses, nevertheless, two weak parts—one about ¼ inch from the cornea, and it is here the sclerotic ruptures from violence ; and another at the entrance of the optic nerve—the lamina cribrosa—where the tunic is pierced by numerous apertures for the nerve bundles. In increased intra-ocular tension (**glaucoma**), this latter portion bulges, producing the ophthalmoscopic appearance known as 'cupping of the disc.'

The **Choroid** carries the main bloodvessels of the eyeball. It may be the seat of : (*a*) *Rupture*, in which case the rent takes place in the posterior portion of the tunic, with or without injury to the other coats. The choroid is separated from the sclerotic by two thin membranes, and a lymph space bleeding can therefore readily occur

between the coats without rupture of either. (*b*) *Inflammation:* If this occur, the nutrition of the retina is interfered with, leading to grave disturbance of vision. (*c*) *Growths:* Containing pigment cells as it does, it is not surprising to find melanotic sarcoma occasionally present in the choroid.

The Iris—1. *Coloboma.*—The iris may be the seat of a deficiency or cleft known as a coloboma, which is almost invariably situated at the lower and inner part of the iris, and is due to the persistence of the choroidal cleft in this situation.

2. *Inflammation of Iris* is extremely common owing, to a great extent, to the lavish blood-supply of the part. When inflammation occurs, the process may spread (*a*) to the choroid, having, very probably, previously spread *from* the cornea or sclerotic; (*b*) to the lens—since the posterior surface of the iris touches the lens—resulting in inflammatory adhesions to its capsule (**posterior synechiæ**), or to **secondary** or **inflammatory cataract** when the lens tissue proper is affected — by **anterior synechiæ** are meant adhesions of the iris to the cornea; (*c*) to the ciliary body; in fact, most severe cases of iritis are cases of **irido-cyclitis.** Two important signs of iritis are the alteration in colour and loss of pattern in the membrane, and the sluggish, contracted, or irregular pupil; the alteration in colour and pattern are referable to the congestion and effusion of lymph, the sluggish and contracted pupil to swelling and œdema of the iris, and the irregular pupil to anterior or posteria synechiæ.

3. *Injuries.*—(1) The iris, not being firmly attached at its insertion, may suffer **detachment** without the involvement of other structures; also, in a penetrating wound of the cornea, the membrane, from its delicate yielding structure, is easily prolapsed. (2) The iris derives a large amount of support from the lens; hence, when that organ is dislocated **tremulous iris** is observed. (3) When wounded, the membrane, in spite of its vascularity, does not bleed to any extent, due probably to the contraction of its muscular fibres.

The **Retina** is transparent normally, morbid conditions being recognised by its opacity. This structure is, like the iris, liable to become **detached** from injury and other causes. The retina may be the seat of **glioma**—a

form of sarcoma. The vascular system of the retina is peculiar to itself, being supplied through the arteria centralis retinæ. There is a slight anastomosis with the choroidal vessels about the entrance of the optic nerve, but this is so insignificant that permanent plugging of the central artery means sudden and permanent blindness.

The **Lens** has no bloodvessels, nerves, or connective tissue in its substance; it is thus exempt from a number of diseased processes, but may be the seat of congenital defects, displacements, opacities from injury or senile changes, and, lastly, it may suffer a loss of elasticity, also from the latter cause.

Blood Supply of the Eyeball.—1. *The Short Ciliary Arteries*, which break up into a plexus in the choroid and form the main part of its inner coat.

2. *The Long Ciliary Arteries* (two) which pierce the sclerotic near the entrance of the optic nerve, and run forward to the ciliary region, where they form:

(*a*) A vascular circle at the periphery of the iris (*circulus major*), and

(*b*) A vascular circle at the margin of the pupil (*circulus minor*).

3. *The Anterior Ciliary Arteries*, which divide into:

(*a*) *Perforating Branches.*—These pierce the sclerotic, join the circulus major, and give anastomosing branches to the ciliary processes.

(*b*) *Non-perforating Branches* (episcleral). — These form a narrow zone of fine vessels around the margin of the cornea, named the 'circumcorneal zone.' These vessels are affected in *iritis*, and in inflammation of adjacent parts—*not* in conjunctivitis.

4. The *Conjunctival Vessels* are derived from the lachrymal and palpebral arteries. These vessels are concerned in **conjunctivitis.**

In **conjunctivitis** the injected vessels are in the conjunctiva, are large, tortuous, brick-red in colour, easily moved with the conjunctiva, and emptied on pressure.

In **iritis** the injected vessels are subconjunctival ('circumcorneal zone'), form a narrow zone of small, pink vessels, not moving with the conjunctiva, and not emptied on pressure.

Nerve Supply.—The globe derives its sensory nerves from the first division of the fifth nerve. Its **Motor** nerves are derived from the third nerve for the sphincter iridis and ciliary muscle, and from the sympathetic for the dilator pupillæ.

The **dangerous area** of the eye is a region about 5 mm. ($\frac{1}{5}$ inch) wide around the cornea, corresponding to the region of the ciliary body. Injury of this region is peculiarly liable to be followed by **sympathetic ophthalmia**, in which destructive inflammation of one eye is excited by some irritation in the other.

Glaucoma.—This is a disease of which the salient feature is an increase of the intra-ocular tension of the globe, in some cases to such an extent that the eyeball may give an impression to the finger of marble hardness. The **cause** of this condition is a superabundance of the intra-ocular fluids, which is probably due to certain changes debarring it from escaping as it normally should. In health the excess of fluid leaves the eye at the angle formed by the cornea with the iris; in this angle is a structure—the ligamentum pectinatum iridis—which is pierced by numerous spaces (the spaces of Fontana) that communicate with the canal of Schlemm, a sinus tunnelling the choroid near its corneal junction. The canal of Schlemm is either a vein or a lymph canal, and is in very intimate relation with the veins of the globe. In this manner fluid is able to find its way from the anterior chamber into the venous system. Should the angle mentioned above become blocked from any cause, increased tension in the eye will result; hence the *rationale* of performing an iridectomy in glaucoma—to reopen the angle through which filtration occurs.

The **symptoms** of glaucoma are explained by the increased intra-ocular tension: (1) The hardness of the globe is referable to this cause; (2) the dilated and sluggish pupil, due principally to paralysis of the nerves of the iris; (3) the shallow anterior chamber, because the parts behind are pushed forward; (4) the anæsthetic cornea, due to paralysis of the first division of the fifth nerve; (5) the distended veins, also due to pressure; (6) the severe pain; (7) the 'London fog' and other spectra that afflict the patient, due to pressure of the vitreous on the retina; (8) contraction of the field of vision, from

pressure on the retina and obstructed blood supply : and (9) the cupping of the disc.

The Ear.

The **Pinna** may present various **malformations** : thus, it may be congenitally absent or imperfectly developed ; on the other hand, Nature, in a too lavish mood, may have distributed one or more supernumerary auricles ; again, the region of the ear may present congenital fistulæ, due to non-closure of the first branchial cleft.

The **skin** of the pinna is thin and closely adherent to the cartilage, hence in **erysipelas** of this region there is great swelling and the patient suffers severe pain. Frost-bite is, for various reasons, common in the organ, in spite of a generous blood supply. Beneath the skin of the external ear may be found collections of urate of soda—**tophi**—occurring in gouty subjects, and a collection of blood -- **hæmatoma auris** — is frequently found in lunatics, and which is often, but not invariably, due to traumatism.

The **External Auditory Meatus** is 1¼ inches in length. Direction forwards and inwards ; therefore, to straighten the canal before using the speculum, draw the pinna upwards and backwards. The floor of the meatus is longer than the roof, and the canal generally is narrowest about its middle. Structure : *In adults* the osseous part forms rather more than one half of the tube. *In children* of five or six years the bony and cartilaginous portions are about the same length. *In infants* of one year a third only of the meatus is bony. **Exostoses** grow from the bony part, **polypi** from the soft parts, and **foreign bodies** may, of course, be found in any situation.

The cartilaginous portion (1) contains a large number of ceruminous glands, hence the frequency of '**wax** in the ear'; (2) contains many sebaceous glands, and these occasionally inflame, leading to small but excessively painful abscesses ; (3) contains certain fissures, termed fissures of Santorini, in its floor. These deficiences are filled up by fibrous tissue, but through them occasionally a **parotid abscess** may burst into the meatus.

The **Blood Supply** of the pinna and external auditory meatus is lavish, and is derived from the temporal,

posterior auricular, and a branch from the internal maxillary artery.

The **Nerve Supply.**—(1) The *Auriculo-Temporal Nerve* (a branch of the third division of the fifth) supplies the greater part of the outer surface of the pinna and the greater part of the meatus; hence, frequently repeated **yawning** in ear ailments is due to irritation conveyed to the branches (derived from the same division of the fifth) which supply the muscles of the jaw. Conversely, there

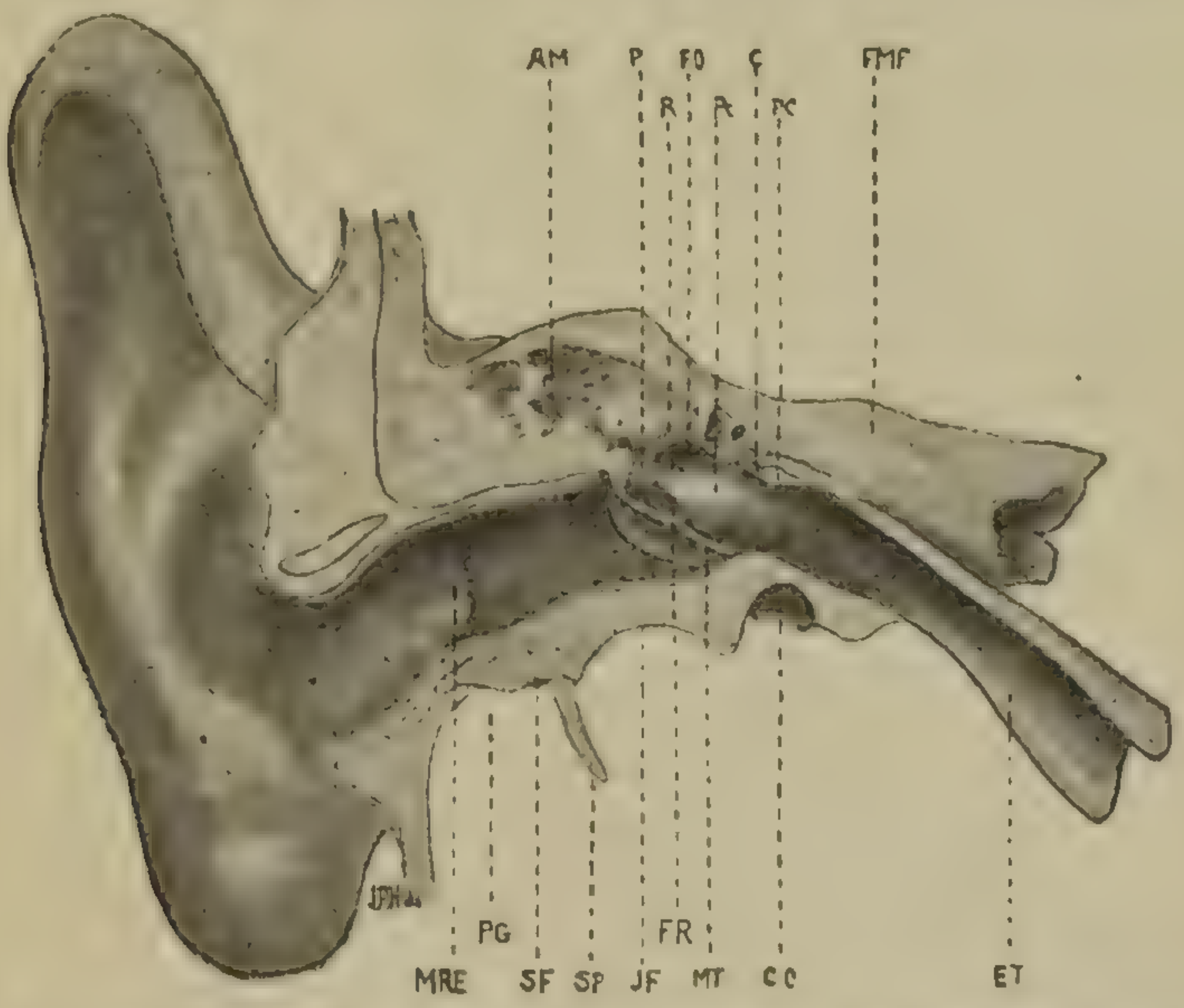

FIG. 2.—DISSECTION OF AURAL CANAL. PO. Parotid gland. SF. Styloid foramen. JF. Jugular fossa. MT. Membrana tympani. CC. Carotid canal. AM. Antrum mastoideum.

may be pain in the ear in **cancer** of the anterior part of the tongue, supplied by the gustatory nerve (from the fifth).

(2) The *Great Auricular Nerve* (from cervical plexus). Pain in the ear has been found to be due to an enlarged gland in the neck pressing on its trunk (Hilton).

(3) The *Auricular Branch of the Pneumogastric* (Arnold's Nerve). The existence of this nerve explains **ear-coughing** and **ear-sneezing** (pulmonary branches of vagus), also **ear-vomiting** (gastric branch), the cough or

other symptom being excited reflexly by some irritation about the meatus or pinna (a limited portion), these parts being supplied by Arnold's nerve.

Relations of the Meatus.—The *upper wall* is in relation with the cranial cavity, being merely separated from it by a thin plate of bone ; for this reason abscess or bone disease in connection with the meatus may spread to the cerebral membranes, resulting in **meningitis.**

The *anterior wall* with the temporo-maxillary joint and a portion of the parotid gland, hence, possibly, the pain felt on moving the jaw in inflamed conditions of the meatus. Cases may be encountered in which this wall has been fractured by a blow on the chin.

The *posterior wall* with the mastoid cells, hence inflammation may spread to them.

The *inferior wall* is in relation with the styloid and vaginal processes, and is of a substantial thickness.

The **Membrana Tympani** is, in health, concave from the outside, transparent, smooth and shining, and from its peculiar curvature shows an appearance known as the 'triangle of light' ; the apex of the triangle—the deepest point of the depression in the membrane, and known as the **umbo**—is just below the centre of the membrane, and corresponds to the attachment of the end of the handle of the malleus ; the handle itself may be seen as a white streak running upwards and forwards. The membrane is obliquely placed ; in the adult it forms an angle of 45° with the horizon, and it is attached to a ring of bone which presents in its upper part a gap—the notch of Rivini. The deficiency is occupied by loose connective tissue, and permits of **pus** in the middle ear escaping into the meatus without the membrane being ruptured.

Paracentesis of the membrane should be performed in the segment below the umbo, because the segment situated superiorly is more vascular and sensitive, and corresponds to the ossicles and chorda tympani nerve.

Relations of the Tympanum.—*Roof :* In relation with the cranial cavity, and separated from the temporo-sphenoidal lobe of the brain by a thin plate of bone and the dura mater ; thus, we may find **septic meningitis** or **abscess** of the brain as a result of the extension of inflammatory processes from the middle ear.

Floor : In relation with jugular fossa and carotid canal,

hence **thrombosis of lateral sinus** or **fatal hæmorrhage** from the internal carotid artery may ensue—the latter only in destructive disease of the tympanum.

Posterior wall: In relation with the mastoid cells, hence **mastoid abscess** has not unfrequently supervened upon middle-ear disease.

Anterior wall: In relation with the Eustachian tube, hence in **throat diseases** the middle ear may become involved.

Mastoid Cells—(1) *Structure.*—In the adult the mastoid cells surround and open into a central space about the size of a pea—the mastoid antrum. The distance of this cavity from the lateral sinus is about $\frac{1}{5}$ inch, and from the external surface of the mastoid process about $\frac{1}{2}$ to $\frac{3}{4}$ inch. In the infant there is no mastoid process proper, and only a solitary air-cell—the antrum—of which the outer wall is very thin; for this reason abscess, in these young subjects, readily points.

(2) **Abscess** of the antrum is common. In **perforating antrum** for the relief of this condition (*a*) avoid the posterior auricular artery (lying in the groove between the mastoid process and the cartilage of the ear), (*b*) enter the drill $\frac{3}{4}$ inch behind the meatus and rather below the level of its upper wall, (*c*) thrust the drill in a direction nearly parallel with the auditory canal—that is, inwards and a little forwards and upwards. The more serious **results** of abscess may be (*a*) thrombosis of the lateral sinus because of the existence of emissary veins connecting the mastoid cells with the sinus, (*b*) meningitis or abscess (usually cerebellar) from extension of the morbid process through the roof of the antrum, (*c*) involvement of the facial nerve as it passes close to the antrum, and consequent neuralgia of that nerve.

The **Eustachian tube** rids the tympanic cavity of secretions, and serves to equalize the pressure on both sides of the membrane. The tube is $1\frac{1}{4}$ inches long, and in adults a quarter of the tube is bony and the remaining three-quarters cartilaginous. Its *direction* is inwards, downwards and forwards; it is in *relation* on the outer side with the tensor palati, the third division of the fifth nerve, and the middle meningeal artery, and on the inner side with the retro-pharyngeal tissue.

Its **pharyngeal orifice** is usually closed, but during

swallowing the orifice is opened, principally by the action of the tensor palati muscle. Prolonged closure will cause **deafness**, which may be brought about in various ways—either by the extension of inflammatory swelling and thickening from the pharynx; by the extension of the hypertrophic change, associated with chronically enlarged tonsils, from those structures; or owing to a mechanical closure, as by a pharyngeal growth.

The tympanum may require inflating by Valsalva's or Politzer's method.

The Nose.

Skin.—(1) The skin over the root and dorsum of the nose is thin and lax, but in the region of the alæ and over the tip of the nose is thick and adherent to the subjacent parts; from this cause inflammatory affections occurring over the cartilaginous portion are painful and accompanied by a large amount of congestion owing to the free blood-supply. (2) It contains a large number of sebaceous glands, hence **acne, acne rosacea,** and **acne hypertrophica** (a very chronic form attended by hypertrophy of the skin and subcutaneous tissue) may be found in this situation. (3) The skin in this region is a frequent seat of **lupus erythematosus, lupus vulgaris,** and **rodent ulcer.** (4) Its blood supply is free, and at the nostrils terminal; for the former reason **plastic operations** are frequently successful and **wounds** heal kindly, and for both reasons combined vascular engorgement is liable to occur in inflamed conditions. **Frost-bite** may occur in this situation, as in the pinna. (5) The nerve supply is: (*a*) the nasal branch of the first division of the fifth nerve to the root of the nose, alæ and nostrils, hence **lachrymation** after a blow on the nose—the lachrymal gland being also supplied by the first division of the fifth; (*b*) the second division of the fifth nerve supplies the rest of the integument.

The **cartilaginous part** of the nose is frequently destroyed by lupoid or syphilitic ulceration. A peculiar flattening of the bridge of the nose may occur in congenital syphilis. The subjects of this disease frequently suffer from a severe catarrh of the nasal mucous membrane—'snuffles.' The result of this is malnutrition and imperfect growth of the parts,

Nasal Bones.—The root of the nose is a common seat of **meningoceles** and **encephaloceles**, which protrude through the suture between the nasal and frontal bones. The nasal bones are frequently fractured by direct violence.

Fracture.—(*a*) Is most common through the lower third, where the bones are least supported. (*b*) Is not attended by displacement due to muscular action, any malposition of the bones being referable to the direction of the force. In fractures of the upper third the cribriform plate may be broken. (*c*) Is attended by rapid union; in one case the fragments were reported to have united in a week (Hamilton). (*d*) May be associated with **subcutaneous emphysema**, if the nasal mucous membrane be torn.

The Nasal Cavities.—The **anterior nares** can be examined and explored by the following methods:

1. *By reflecting light* into the anterior nares, the head being tilted back because the plane of the nostril is below that of the floor of the nares. (2) *By introducing a finger.* This may be supplemented by the introduction of another finger through the posterior nares, when the two fingers can be made to meet in the nasal fossa. Soft polypi can be removed by tearing them away by the fingers introduced in this way. (3) *By Rouge's operation*, which consists of separation of the upper lip and division of the nasal septum, the flap so formed being dissected up until the anterior nares are sufficiently exposed.

The **posterior nares** can be examined and explored by: (1) *Posterior rhinoscopy*, a little mirror being introduced behind the soft palate, and light reflected on it through the mouth. The **parts seen**, in a favourable subject, are the posterior nares, the septum, part of the superior and inferior turbinated bones, the middle turbinated bone, the middle meatus, part of the inferior meatus, the orifice of the Eustachian tube, and the mucous membrane of the upper part of the pharynx. (2) *By the finger* introduced through the mouth and insinuated behind the soft palate, the parts felt are, according to Treves, the same as the above.

In **plugging** the posterior nares, an operation occasionally required for epistaxis, the plug used should be, roughly, about the size of the terminal phalanx of the

thumb, that is, about 1¼ inches vertically and ½ inch transversely, these being the dimensions of either aperture in the adult skull.

In using the **nasal douche** the nozzle of the syphon-tube is inserted into one nostril, and the patient instructed to keep his mouth open; the fluid then passes backwards through the nostril, over the soft palate, and forwards through the other nostril, and so externally. When the mouth is open there is an irresistible tendency to breathe through it alone, and to effect this the velum

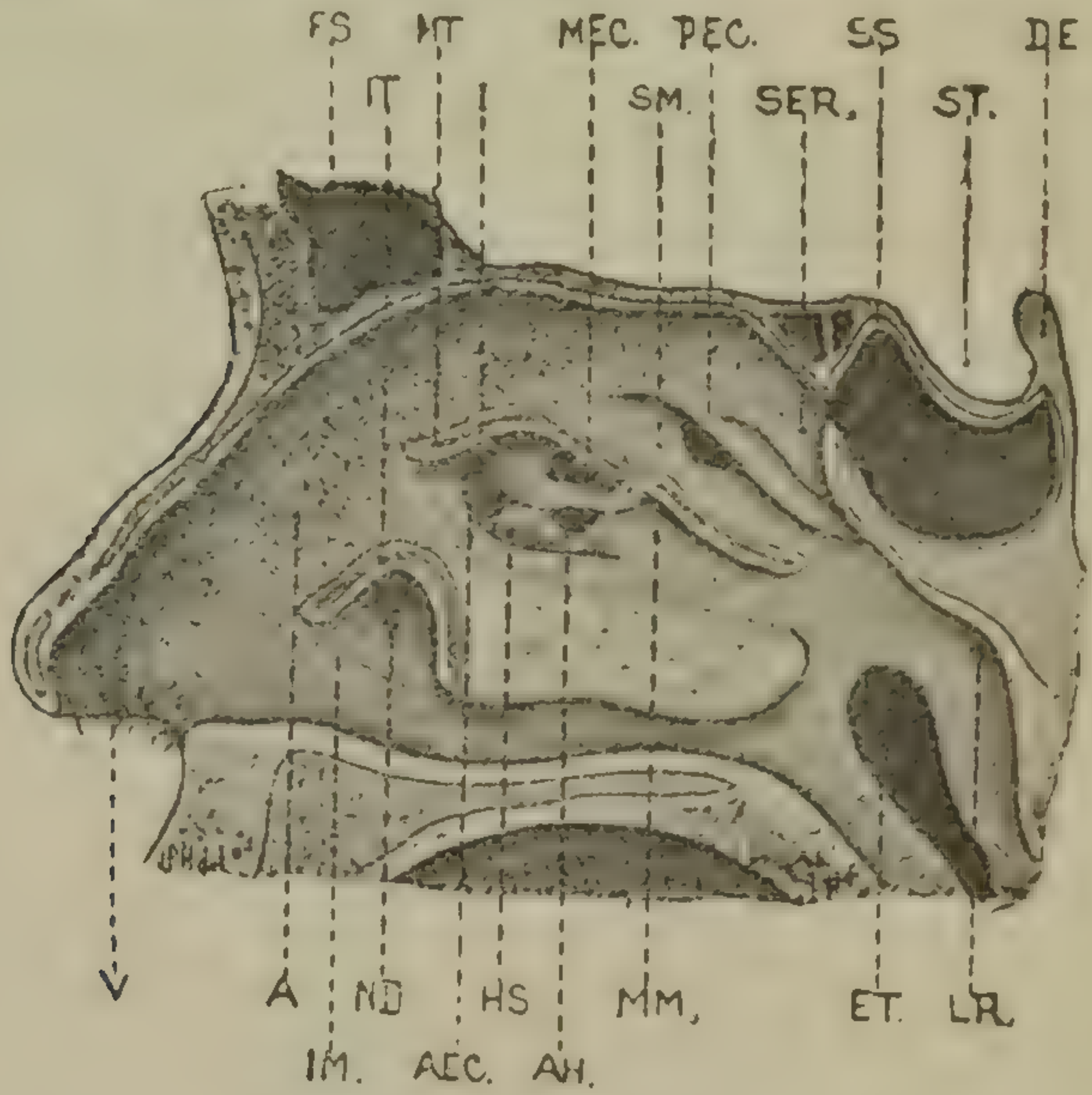

FIG. 3.—OUTER WALL OF RIGHT NASAL FOSSA (AFTER CUNNINGHAM).

is raised and the nostrils cut off from the pharynx, thus the fluid is able to travel over the platform improvised by the raised soft palate.

Nasal Fossæ—A. *Boundaries.*—The *roof* is extremely narrow (⅛ inch), and formed mainly by the cribriform plate of the ethmoid. The *floor* is wider at the centre than at either end, and the nasal fossæ, generally, are wider from above downwards than from side to side, hence the blades of a polypus forceps, when introduced, should be opened

vertically. The fossæ are also wider below than above. The floor is smooth, and slopes slightly from before backwards ; it is formed by parts of the superior maxillary and palate bones. The *septum* is formed principally by the perpendicular plate of the ethmoid and by the vomer, and secondarily by parts of the frontal, sphenoid, superior maxillary, nasal, and palate bones ; to these seven bones must be added the triangular fibro-cartilage, which forms part of this boundary. The septum is usually deflected, and in the majority of cases towards the left ; the deflection has been known to be sufficient to block the nostril. The septum is occasionally perforated or destroyed by syphilitic ulceration, or by the fumes of bichromate of potassium (*bichromate disease*).

The *outer wall* (1) is formed by parts of six bones, viz., the superior maxillary, lachrymal, ethmoid, palate, sphenoid, and inferior turbinate. (2) Presents three meatuses formed between the three turbinate bones. (3) Presents various *openings* (Fig. 3)—

(*a*) Into the superior meatus : spheno-palatine foramen, posterior ethmoidal cells (PEC).

(*b*) Into the middle meatus : anterior ethmoidal cells, which open into the meatus by means of the **infundibulum**, a deep gutter running down the wall of the meatus and opening into that passage ; frontal sinus, antrum (A.H.)

(*c*) Into the inferior meatus : nasal duct (N.D.). The orifice of this duct is wide, and situated 1 inch from the opening of the nostril and $\frac{3}{4}$ inch above the nasal floor.

B. *Communications.*—Each nasal fossa communicates—

(1) In front with the face, and posteriorly with the pharynx. (2) With four **cavities**—(*a*) the orbit by the lachrymal canal, (*b*) the mouth by the anterior palatine canal, (*c*) the cranium by the olfactory foramina ; this relation explains the fact that **meningitis** may occur in inflammation of the nasal fossa ; and, again, if the roof of the fossa be **fractured**, as, for example, by a sharp body thrust through the cribriform plate, cerebro-spinal fluid will probably flow through the nostrils ; lastly, a **meningocele** may protrude through the nasal roof, (*d*)

the spheno-maxillary fossa by the spheno-palatine foramen.

The **mucous membrane** of the nose presents the following noticeable points : (1) The membrane is thick and vascular over the turbinate bones and the lower two-thirds of the septum ; whilst, on the other hand, over the nasal floor and in the intervals between the turbinate bones it is thinner, and markedly so in the sinuses and antrum. Over the lower turbinate bone is the 'erectile body,' formed of a species of cavernous tissue. This structure, when distended with blood, forms a tumid swelling, which may completely obstruct the nostril in which it is situated. If in a state of chronic inflammation, the mucous membrane over the inferior turbinate bone may be mistaken for a polypus, an error in diagnosis which can be avoided by ascertaining the mobility of the suspected growth by means of a probe, polypi being movable, whilst the hypertrophied mucous membrane is not. The great vascularity of the normal mucous membrane is probably a provision for raising the temperature of the inspired air. (2) It is provided with a liberal supply of glands, which may hypertrophy, and which in **chronic coryza** secrete a profuse watery fluid. There is also adenoid tissue in abundance, which is the element chiefly involved in strumous affections of the part. (3) Being somewhat lax over the septum, a blow on the nose may give rise to a **hæmatoma** beneath the membrane.

Nasal polypi are common, and occur in three forms—the mucous, the fibrous, and the malignant.

Mucous Polypi.	Fibrous Polypi.
Seat.	
Mucous membrane of outer wall, especially over inferior and middle turbinate bones.	Grow usually from periosteum of base of skull or from roof of nasal fossa. Are usually sarcomatous in nature.
Colour.	
Yellowish gray.	Deep red.

Number.

Multiple.	Single, with a broad base.

Age.

Usually about middle life.	In younger persons.

Epistaxis.

Absent.	Present, and frequently severe.

Deformity.

Absent usually.	Marked. The eyes are widely separated, the bridge of the nose expanded, and a peculiar cast of countenance is produced known as 'frog face,' from a supposed likeness to that amphibian. It is often associated with 'watery eye,' from obstruction of the nasal duct.

Malignant polypi, either sarcomatous or carcinomatous in nature, may arise in the nasal cavities, naso-pharynx or antrum.

The **Blood Supply** of the nasal cavity is from the internal maxillary, the ophthalmic and the facial *arteries.* Of the *veins,* it is to be observed that some enter the superior longitudinal sinus through the foramen cæcum; hence **thrombosis,** septic or otherwise, and **septic inflammation,** may extend to the cerebral sinuses.

Epistaxis is for various reasons common, in children especially so.

Nerve Supply.—The olfactory nerve for the sense of smell, and for common sensation the nasal branch of the ophthalmic, twigs from the superior maxillary, the Vidian, naso-palatine, the descending anterior palatine, and nasal branches of Meckel's ganglion.

The Sinuses.—The *frontal sinuses* are not present before the age of ten years, but by twenty years of age they are well developed. A fracture, as has been stated

above, may, by implicating the frontal sinuses, involve the external table only. **Bony tumours** frequently grow from the interior of these sinuses, and are named **enostoses.** The **antrum**, or maxillary sinus, unlike the preceding sinuses, exists at birth, but reaches its largest dimensions late in life. The cavity may be the seat of dropsy, suppuration cysts, or tumours. In the case of **tumours,** they may invade the neighbouring cavities of the orbit, nose, or mouth, or pass through the anterior wall to the cheek; they do not as a rule spread backwards. The infra-orbital nerve may be pressed upon by growths, and produce **neuralgia.**

In **tapping** the antrum the operation is performed either (1) by extracting the first molar tooth, if carious, of which the fangs are in close relation with the cavity; (2) by making an opening in the thin canine fossa immediately above the second bicuspid tooth; or (3) by a new method, possessing the advantages of entering the antrum at its most dependent part, and of not allowing food to obtain access to the cavity, by drilling through the bone obliquely between the roots of the second bicuspid and first molar teeth.—Brown.

The Face.

The **Skin** (1) is a favourite seat of certain destructive processes and ulcers; thus, **cancrum oris, rodent ulcer,** and **malignant pustule** are met with. (2) Is thin and fine, and there is an absence of dense fascia, hence **facial abscesses** evince a tendency to 'point' rapidly. (3) Possesses an abundant supply of sudoriferous and sebaceous glands, hence a common situation for **acne.** (4) The facial tissues are mobile and vascular, hence **plastic operations** are usually successful, and the laxity of the cellular tissues explains the fact that a slight 'puffiness' of the lower lid is frequently the precursory indication of general dropsy.

The **Blood Supply** is lavish; **nævi** are, therefore, common in this part. An interesting point about the free irrigation of the facial tissues with blood is that it is an important factor in determining the comparatively low mortality in injuries of the region. The other causes, in addition to the extraordinary reparative power

which is referable to the excellent blood supply, are the absence of vital organs, the absence of extensive splitting due to the softness and thinness of the facial bones, and the presence of cavities by which the discharges can escape.

The arterial supply is principally from the facial artery and its branches.

Facial Artery—*Course.*—It arises from the external carotid artery a little above the lingual, passes forwards and upwards beneath the posterior belly of the digastric and the stylohyoid muscle and submaxillary gland; it then crosses the jaw-bone in front of the masseter, where it is readily felt pulsating, and makes in a tortuous manner for the angle of the mouth and the inner angle of the eye. The lachrymal sac is internal to the vessel, therefore in operating for **fistula lachrymalia** the sac should be opened on the outer side. **In bleeding from the lips** the facial artery should not be ligatured as a controlling measure, on account of its free anastomoses. In such a case the bleeding can be temporarily arrested by compressing the coronary arteries through the lips, by means of the finger and thumb or by a specially devised clamp, whilst for its permanent stoppage sutures should be passed deeply through the cut edges of the lip, almost to the mucous surface, or the wounded vessels may be picked up and tied in the usual manner.

The **Facial Vein** (1) does not accompany the artery in its meanderings, but runs a straight course from the inner angle of the eye to the anterior border of the masseter, and is only in contact with the other vessel at the lower border of the jaw. (2) It possesses no valves, and remains patent when divided. The consequence of this patency is that **septic absorption** is favoured, and thus it not unfrequently happens that phlegmonous inflammation of the face sets up **thrombosis** of the facial vein. (3) It communicates (*a*) **with the intracranial circulation** by two channels: on the one hand, through its tributaries, the angular and supra-orbital veins, which communicate with the cavernous sinus by means of the ophthalmic vein; and, on the other hand, less directly by means of 'its deep branch, which communicates through the pterygoid plexus with the cavernous sinus by branches which pass through the foramen ovale and

foramen lacerum medium' (Gray). Hence, in facial carbuncle, death may occur from thrombosis of the cerebral sinuses. (*b*) With the internal jugular veins, of which it is a tributary.

Nerve Supply.—The sensory nerve of the face is the fifth, and the motor nerve is the facial. Neuralgia of the fifth nerve is common, and each of its three divisions has been divided or resected for this affection. In order to divide the nerves, the foramina by which they respectively appear on the face must be found.

Supra-orbital Foramen.—Found at the junction of the inner with the middle third of the upper margin of the orbit ; the nerve is divided by an incision, $1\frac{1}{2}$ inches long,

FIG. 4.—COURSE OF SUPERIOR MAXILLARY DIVISION OF FIFTH NERVE (DIAGRAMMATIC). SMV. Superior maxillary division V. FR. Foramen rotundum. M. Meckel's ganglion IC. Infra-orbital canal.

along the supra-orbital margin, with its centre opposite the supra-orbital notch.

Infra-orbital Foramen.—About $\frac{1}{4}$ inch below the margin of the orbit, and in a line drawn from the supra-orbital foramen to the gap between the two bicuspid teeth in both jaws. The infra-orbital nerve may be divided either at its point of exit, in its course in the infra-orbital canal, or at the foramen rotundum, with **excision of Meckel's ganglion.** This last operation has been performed for severe epileptiform neuralgia of the fifth nerve, and

Carnochan's operation for the removal of the ganglion hinges upon the fact that the infra-orbital nerve and its continuation (the superior maxillary) extend from the infra-orbital foramen on the one hand, to Meckel's ganglion, in close proximity to the foramen rotundum, on the other; the ganglion may accordingly be found by tracing the above-mentioned nerve backwards, from its appearance at the infra-orbital foramen until the desired structure is arrived at (Fig. 4). For the details of the operation the student is referred to the standard text-books on surgery and surgical anatomy.

Mental Foramen (*for dental nerve*).—Found in the same line as the preceding foramina, midway, in the adult, between the alveolus and the lower border of the jaw. The dental nerve can be divided by an incision over the site of the foramen; it has also undergone section before its entry into the mental foramen.

The **Buccal Nerve** may be divided by a vertical incision through the mucous membrane of the mouth and the buccinator, just in front of the anterior border of the ramus of the lower jaw (Stimson).

The **Lingual Nerve** may be divided in cancer of the tongue (*vide* **Tongue**).

Parotid Gland.—The major part of the parotid gland is lodged in a hollow, bounded behind by the mastoid process and sterno-mastoid muscle, and in front by the ascending ramus of the lower jaw: extension of the head and protrusion of the chin increase the dimensions of the space; flexing the head reduces them. This should be borne in mind in operating about the space.

1. The **boundaries** of the parotid gland are as follows: *Above*, the zygoma; *below*, a straight line from the angle of the jaw to the anterior border of the sterno-mastoid; *behind*, the external auditory meatus, the mastoid process, and the sterno-mastoid, hence **parotid abscesses** have discharged through the meatus; *anteriorly*, the gland stretches over the masseter muscle.

The *deep surface* of the gland is in *relation* with the sterno-mastoid muscle and mastoid process; with the articulation of the lower jaw and with the cartilaginous part of the meatus (hence inflammation of the temporo-maxillary joint has followed parotid abscess, and the pus from such an abscess has burst into the meatus); with a

part of the pharynx ; with the great vessels and nerves of the neck ; and with the foramen ovale. Pus may track along the branches of the fifth nerve, and pass through this foramen into the skull. Bearing these relations in mind, the complete removal (surgically) of the parotid gland must be recognised as impossible.

2. A **peculiar fascia**, derived from the cervical fascia, invests the parotid gland, and forms a distinct sac, in which the structure is lodged. The sac is closed above, open below, and deficient at its lower and inner part (between the styloid process and internal pterygoid muscle); from this cause **parotid abscesses** tend to mount upwards towards the temporal or zygomatic fossæ, or to pass inwards towards the pharynx through the breach at the lower and inner portion ; or, conversely, pus from a **retro-pharyngeal abscess** may evacuate itself in the parotid region *viâ* the gap in the fascia.

3. The parotid gland *contains* certain important structures, the more notable being the external carotid artery and its terminal branches and the facial nerve, and is *separated* by a thin layer of fascia, merely, from other structures, viz., three nerves—the vagus, glosso-pharyngeal and hypoglossal—an artery—the internal carotid ; hence a stab in this region may wound either the external or internal carotid artery—and a vein—the internal jugular. The theory that pressure on this vein is responsible for the cerebral hyperæmia, occasionally noticed in mumps, is possibly correct.

Line of External Carotid Artery.—The artery is very nearly in a line (slightly arched forwards) drawn from the cricoid cartilage to the front of the meatus of the ear ; it enters the gland, not at its inferior border, but $\frac{3}{4}$ inch above the angle of the jaw, and divides into the temporal and internal maxillary arteries opposite the condyle of the jaw.

Line of Facial Nerve.—A line drawn from the spot where the anterior border of the mastoid process meets the cartilage of the ear, forwards and a little downwards across the parotid gland, will represent the nerve.

4. The parotid gland is a common seat of **tumours** and **abscesses** which cause much suffering from the unyielding nature of the capsule of the gland. In **operating** upon the gland, avoid wounding (*a*) the external carotid

artery by not entering the knife behind a line drawn from the condyle of the lower jaw to its angle, and (*b*) the facial nerve and its branches, by cutting parallel to these; it is peculiarly important to avoid any injury to the nerve, as intractable **facial paralysis** is apt to result.

Many lymphatic glands exist in and upon the parotid gland, and when enlarged they form one variety of 'parotid tumour.'

5. **Stenson's Duct** is about 2½ inches long, and at the anterior border of the masseter it bends suddenly, almost at a right angle, to pierce the buccinator—a fact to be remembered in probing the duct from the mouth. The orifice of the tube is on a level with the second upper molar tooth; inflammation may therefore spread from the mouth to the parotid gland along the duct. The **course** of the duct is in a line from the lower margin of the concha to midway between the alæ of the nose and the red margin of the lip. A wound of the duct will probably lead to **salivary fistula.**

The Upper Jaw.

Fracture and Repair.—The fragility and hollowness of the bone predispose it somewhat to fracture, and the fracturing body may become lodged in the antrum. The bone is liable to break from direct or indirect violence; the former might be produced by a blow from a 'knuckle-duster'; and a fall on the chin has been known to cause the latter.

Although the periosteum of the upper jaw is indisposed to form new bone, unlike that of the lower jaw, extensive injuries are often wonderfully repaired, due in great measure to the abundant vascularity of the parts.

Excision.—The **incision** begins parallel to the lower eyelid, is continued down the side of the nose, round the ala, and through the middle of the upper lip.

Table of the Chief Structures divided in Excision of Upper Jaw.

1. Skin and Fascia
   - Superficial
   - Temporal (later)

   } also the mucous membrane of the lip.

2. Muscles of
   - Eyelids and eye
     - Orbicularis palpebrarum.
     - Inferior oblique.

     } also lachrymal sac or nasal duct and tendo oculi.
   - Nose
     - Levator labii superioris alæque nasi.
     - Compressor nares.
     - Depressor alæ nasi.
   - Mouth
     - Orbicularis oris.
     - 3 Levators.
     - 2 Zygomatici.
     - Buccinator.

3. Bony attachments to
   - Malar.
   - Palate.
   - (Nasal, frontal, and lachrymal, by nasal process of superior maxillary.)
   - Pterygoid and palate, behind.

4. Nerves ...
   - Facial (branches); chiefly those that appear on the face.
   - Second division of fifth; branches that appear on the face, also the infra-trochlear nerve and trunk of second division of fifth.

5. Arteries
   - Temporal (branches, 3).
   - Facial (trunk near angle of jaw and three branches).
   - Internal maxillary (branches, 5, and its termination, probably).

6. Veins ... The corresponding veins.

NOTE.—The student is advised to become familiar with the order in which the structures are cut through.

The Inferior Maxilla.

Fracture of the lower jaw presents the following points of importance: (*a*) certain anatomical conditions tend to obviate the occurrence of fracture. (1) The horseshoe shape of the bone endows it with a certain amount of spring. (2) Its density of structure gives it strength. (3) Its mobility and (4) the buffer-like inter-articular cartilages tend to minimize the effects of violence. (*b*) Fracture of the inferior maxilla is usually from direct violence, and is, as a rule, compound from the adherence of the gums, which become lacerated when fracture occurs. (*c*) The **position** of the break is usually in the neighbourhood of the canine tooth, where the bone is weakened by the excavations of its substance required for the mental foramen and canine socket; less frequently the fracture takes place at the angle, and least commonly of all the bone is found to have given way at the thickly-made symphysis. One of, or both, the condyles are occasionally broken, and very rarely the coronoid process —the latter fracture is said never to unite. (*d*) The **displacement** varies with the position and line of the fracture and the nature of the force. If the bone gives way at the canine fossa and the fracture is oblique and unilateral, the displacement will not be marked, and may be merely indicated by a slight indrawing of the upper fragment by the mylo-hyoid muscle. Nor will the fragments be much disturbed in fractures of the ramus, muscular tissue being attached nearly equally to both fragments; but in bilateral fractures of the body of the bone the maximum displacement is seen, the anterior fragment being drawn backwards and downwards by the jaw depressors, whilst the posterior fragment is drawn up by the elevators of the jaw. (*e*) The **concomitant injuries** are displacement of the teeth in the majority of cases, and sometimes injury to the inferior dental nerve in fractures about the canine fossa.

The Temporo-Maxillary Articulation: Ligaments. —(1) The *external lateral*, passing from the tubercle of the zygoma downwards and backwards to the neck of the lower law.

(2) The *internal lateral*, passing from the spine of the sphenoid to the inner margin of the dental foramen;

between this ligament and the jaw are the internal maxillary artery and the inferior dental vessels and nerves.

(3) The *stylo-maxillary*, from the styloid process to the angle of the lower jaw ; this ligament separates the parotid from the submaxillary gland.

(4) The *capsular ;* the anterior and posterior portions of the ligament, not being protected in the same manner as its lateral portions, offer, especially the anterior, comparatively little resistance to the escape of **pus** from the joint.

(5) The *interarticular cartilage*, which is connected laterally to the ligaments surrounding the joint and in front to the tendon of the external pterygoid muscle. The attachment of the tendon to both bone and cartilage tends to provide against the contingency of subluxation of the cartilage. The joint is in relation posteriorly with the bony meatus and, a little to the inner side, the middle ear. It is separated from these structures by a thin wall of bone ; hence a blow on the chin would be a very grave accident, were it not for the direction of the external lateral ligament resisting backward movements of the condyle, and thus preventing a fracture of the osseous wall posterior to it.

Dislocation of the Lower Jaw. (1) Direction : forwards only ; the dislocation is usually bilateral. (2) Cause : usually 'spasmodic muscular action when the mouth is open.' It has occurred during such actions as yawning or laughing, or even in the course of violent talking ; in one reported case a lady unhappily sustained a bilateral dislocation whilst administering a 'curtain lecture' to a delinquent spouse. (3) Mechanism : the condyle, with the interarticular fibro-cartilage, is drawn on to the eminentia articularis ; if the external pterygoid muscle now contract vigorously, the condyle is drawn over the eminence into the zygomatic fossa, the cartilage remaining behind.

Subluxation of the lower jaw is an incomplete dislocation, due to laxity of the ligaments, in which the condyle slips for a moment in front of the fibro-cartilage.

Excision of the lower jaw is best performed by an **incision** through the lower lip down to the point of the chin, and then carried back along the lower border of the jaw, and vertically upwards along the ramus to the lobule of the ear.

Table of the Chief Structures divided in Excision of Lower Jaw (one half).

1. Superficial Structures—Fascia and platysma.

2. Muscles of...
   - Jaw ...
     - Masseter, internal and external pterygoid and temporal (elevators).
     - Anterior belly digastric, genio-hyoid and mylo-hyoid (depressors).
   - Mouth...
     - Depressor labii inferioris.
     - Levator menti.
     - Orbicularis oris.
     - Buccinator.
   - Pharynx
     - Inferior-constrictor (a few fibres).
   - Tongue
     - Genio-hyoglossus—if incision be through symphysis.

3. Nerves ...
   - Inferior dental.
   - Facial twigs.
   - Auriculo-temporal (part of).
   - Nerve to mylo-hyoid.
   - Nerve to masseter.

4. Arteries ...
   - Inferior dental.
   - Facial and submental branch.
   - Inferior coronary.
   - Inferior labial.
   - Mental and masseteric branches.

5. Other Structures
   - Part of parotid gland, probably.
   - Stylo-maxillary ligament.
   - The bone, divided usually on one side of symphysis.

Parts in Risk of being Injured.

(*a*) *Structures met with in disarticulating jaw:*

Arteries
- Internal maxillary—avoided by keeping knife close to bone.
- Middle meningeal.

Nerves
- Auriculo-temporal.
- Chorda-tympani, and branches of third division of fifth nerve.

A vein, the internal maxillary.

(*b*) *Other structures:*
Facial nerve—avoided by not carrying vertical part of incision too high up.
Lingual nerve.
External carotid artery—avoided by not carrying incision too far back.

The Lips.

1. The **Relation** of the structures from without inwards is the following: (1) Skin; (2) superficial fascia; (3) orbicularis oris; (4) coronary vessels: the coronary arteries are nearer the mucous membrane than the skin, hence may be wounded against the teeth; (5) mucous glands: these glands are numerous, and are apt to give rise to **mucous cysts** from closure of the duct and subsequent distension of the gland; (6) mucous membrane.

2. In **injuries** of the lips, if there be subsequent inflammation, they swell considerably, containing as they do a large amount of connective tissue. If there is much loss of substance in consequence of injury (or disease), the laxity of the lips allows, on the one hand, considerable contraction and deformity to take place, while, on the other hand, this same looseness of tissue, combined with the abundant vascularity of the part, predisposes to the success of **plastic operations.**

Blood and Nerve Supply.—The lips are well supplied with blood, hence they are frequently the seat of **nævi** and other vascular tumours.

The upper lip is supplied by the second division of the fifth nerve, and the lower lip by the third division. **Herpes** frequently occurs along the course of the labial nerves (herpes labialis).

The free border of the lower lip is a very common seat of **epithelioma.**

The **Buccal Cavity**, when examined, presents the following noticeable points:

(*a*) **Ducts of Salivary Glands.**—(1) The orifice of Wharton's duct (submaxillary) is on the floor of the mouth, and on either side of the frænum. It is indicated by a small papilla. In **calculus** of this duct there is severe pain, owing partly to the indistensible nature of the tube, and partly, probably, to the contiguity of the

lingual nerve. (2) The orifice of Bartholin's duct (one of the sublingual ducts) opens either with, or in close relation to, the foregoing. The remainder of the ducts from the sublingual gland open, on either side, on a ridge of mucous membrane on the floor of the mouth (*vide infra*).

(*b*) **Salivary Glands.**—(1) The submaxillary gland is felt through the mucous membrane of the floor of the mouth a little in front of the angle of the jaw, the gland being pushed up from the outside. (2) Each sublingual gland is indicated by a ridge on the floor of the mouth, passing forwards and inwards from alveolus to Wharton's papilla. Its ducts (eight to twenty in number) open on the summit of this ridge. **Ranula** is 'a cystic tumour with mucous contents' situated in the sublingual region, and due either to the enlargement of one of the mucous follicles in the neighbourhood, or to obstruction of some of the acini (not the main ducts) of the sublingual or submaxillary glands. By **acute ranula** is meant a cystic tumour in the sublingual region, which forms and increases with great rapidity, and whose origin is said to be in the *sublingual bursa mucosa*—a small space between the mucous membrane of the floor of the mouth and the attachment of the genio-hyoglossus (near lower border of jaw).

(*c*) The **Pterygo-Maxillary Ligament**—a prominent fold running downwards and forwards behind the last molar tooth.

(*d*) The **Lingual Nerve**, which lies about $\frac{1}{2}$ inch from the last molar tooth between it and the anterior pillar of the fauces. A line drawn from the middle of the crown of the last molar to the angle of the jaw would cut the nerve; hence, in Moore's operation for division of the nerve, to relieve pain in **cancer of the tongue**, this line is taken as the guide, and the knife being entered $\frac{3}{4}$ inch behind and below the last molar tooth, and an incision made down to the bone and towards the tooth, the nerve is divided as it crosses the line.

(*e*) The **Coronoid Process** of the lower jaw.

A **space** exists behind the last molar tooth, through which, by means of the catheter, patients with trismus can be fed.

The Tongue.

The Tongue is firm and dense, but contains a fair amount of connective tissue. In **inflammation**, therefore, the organ swells considerably. **Foreign bodies** not unfrequently become lodged in its substance, and **mucous cysts** are occasionally met with near the base of the tongue, developed from the mucous glands prevalent at that part.

Blood Supply.—The tongue is mainly supplied by the lingual artery (ranine and dorsalis linguæ branches), and, in addition, branches from the ascending pharyngeal and the tonsillar branch of the facial are distributed to the organ. The tongue being extremely vascular, **nævi** are met with, and **excision** is rendered a grave operation from the danger of hæmorrhage. The **Ranine Artery** is indicated in position by two ridges of mucous membrane on the under surface of the tongue. The blue ranine veins, which can be readily seen, lie in close contiguity to the arteries, but the latter are at a deeper level, and eventually run forward on either side of the frænum. Thus, in cutting the frænum when abnormally short ('tongue-tie'), **fatal hæmorrhage** has been known to occur from the wounded artery, and the practical deduction from this is that the frænum should be divided close to the jaw, and should not exceed a mere snip.

The **Lymphatics** of the tongue are large and numerous. In **macroglossia** these lymphatics are greatly dilated, and an increase of lymphoid tissue takes place, the organ occasionally attaining an enormous size. Course: They follow the ranine veins, pass through some glands lying on the hyo-glossus, and finally reach the deep glands of the neck near the bifurcation of the common carotid. In **cancer** of the tongue, glandular infection is to be sought for in this position. Other glands may also be affected: (*a*) the submaxillary glands in epithelioma of the anterior part of the tongue, and (*b*) the glands at the angle of the jaw, when the posterior part of the organ is affected.

Nerve Supply.—1. *Motor:* the hypoglossal. 2. *Common sensation:* (*a*) the lingual for the anterior two-thirds, hence reflex **spasmodic contraction of the jaws** in

painful ulcer of this region; (*b*) the glosso-pharyngeal for the posterior third; (*c*) a filament from the superior laryngeal, towards the root. 3. *Special sense of taste:* (*a*) the chorda-tympani (from facial) for anterior two-thirds; (*b*) the glosso-pharyngeal for the posterior third.

Excision of the Tongue.—The tongue may be removed by one of the following methods:

(*a*) **As a rule**, through the mouth, preferably by Whitehead's method, traction being made on the organ by a silk ligature passed through its tip, and its attachments divided by a series of snips; if possible the linguals are tied before division.

(*b*) **If half the tongue** is to be removed, a modification of this operation may be employed, the tongue being split down the centre and the diseased half removed.

(*c*) **If more room is required**, *e.g.*, when the submaxillary glands are affected, Kocher's operation may be performed; in this procedure a preliminary tracheotomy is done, and the tongue is removed through the neck by a curved incision in the submaxillary space. Regnoli's operation, of removing the tongue through the floor of the mouth, is an efficient substitute for the above.

(*d*) **If still more room is required**, the operation recommended by Syme, in which an incision is made through the lower lip down to the inferior-maxillary bone, and the symphysis of the jaw sawn through, may be found advisable.

Table of the Parts divided in removing the Entire Tongue.

1. The Lingual
   - Connections
     - In front—Frænum.
     - Laterally—Reflection of mucous membrane to gums.
     - Behind—Glosso-epiglottic folds.
   - Muscles ...
     - Genio-hyo-glossus.
     - Hyo-glossus.
     - Stylo-glossus.
     - Palato-glossus.
     - Linguales—Superior and inferior.
   - Nerves and Vessels.

2. Some Small Arteries. { Branches of ascending pharyngeal. Branch (tonsillar) of facial.

NOTE.—Bleeding may take place from these branches, and also from the dorsalis linguæ, even when both lingual arteries have been ligatured through the neck. Hæmorrhage from the tongue can always be arrested by passing two fingers behind the root of the organ and pressing it forward.

The Palate.

Cleft Palate and Hare-Lip—Explanation of Occurrence.—'The upper lip is developed from the fronto-nasal process and the maxillary processes, which in the normal course of development fuse in front of the mandibular fissure. Should this fusion fail to take place on either or both sides, a single or double hare-lip respectively results. If the inward growth of the palatine processes, which should take place to separate the nasal and buccal cavities, fails, cleft palate occurs' (Ashby and Wright).

The Operation for Cleft Palate.—A. *Uranoplasty*—the operation on the hard palate. (1) The soft coverings of the hard palate are stripped off to form flaps, and the dissection of these flaps is rendered easy, (*a*) because the mucous membrane and the periosteum covering the hard palate are so intimately connected as to form practically one membrane; (*b*) because the coverings are dense and tough and—near the alveolus—thick, from the presence of mucous glands. (2) The next step is to make liberating incisions to obviate the tension which would otherwise result when the flaps were united; and since they depend for their blood supply principally upon the descending palatine arteries, the position of these vessels should be borne in mind. Each artery emerges from the posterior palatine canal, close to the inner side of the last molar tooth, and runs forwards and inwards to terminate at the anterior palatine canal, close to the canine tooth, therefore (*a*) make the incisions along the inner side and close to alveolus, and (*b*) avoid the neighbourhood of the posterior palatine foramen, and do not let the incisions pass forward beyond the canine tooth. By observing these precautions the artery will escape injury. (3) Finally,

silver sutures are introduced, and the edges of the flaps united.

B. *Staphylorraphy*—the operation on the soft palate. (1) The edges of the flap are pared. (2) They are united by sutures. (3) To relieve tension, one of two procedures may be adopted. The surgeon may either make simple incisions parallel to the cleft, or he may pursue the more elaborate plan of dividing the muscles which tend to widen the cleft. There are three methods with this end in view—Fergusson's, Pollock's, and Bryant's.

In both Fergusson's and Pollock's methods the levatores palati are divided. The levator palati, it should be remembered, arises from the cartilaginous part of the Eustachian tube and adjacent portion of the petrous bone, passes obliquely **downwards** until the soft palate is reached, and then lies **horizontally** on the soft palate, and joins the horizontal part of its fellow from the opposite side. **Fergusson** divides the part passing downwards by a rectangular knife introduced through the cleft, whilst **Pollock** divides the horizontal part by entering a sharp knife just internal to the hamular process. An illustration depicting the posterior nares and palatal muscles should be consulted, in order to fully understand these procedures.

Bryant's method is to divide the palate muscles by a cut with scissors through the whole thickness of the velum, nearly parallel to the cleft.

The **Blood Supply** of the palate is : for the hard palate the descending palatine branch of the internal maxillary artery, and for the soft palate the descending and ascending palatine arteries and the ascending pharyngeal artery.

The Pharynx.

1. **Dimensions.**—The pharynx extends from the base of the skull to opposite the cricoid cartilage and fifth cervical vertebra ; it is 5 inches long, and is wider from side to side than from before backwards. The sac is widest at the level of the tip of the greater cornu of the hyoid bone, and it is most constricted where it joins the gullet. Foreign bodies show a predilection for lodging at this point, and the distance from the teeth—6 inches—unfortunately just precludes the finger dislodging a sub-

stance impacted in this position. The pharynx is very dilatable.

2. The principal **Relations** of the pharynx are : *Above*, the base of the skull ; thus, **fibroid polypi** having their attachment on the under surface of the base can be felt by the finger introduced into the pharynx. *Behind*, the pharynx is in relation with all the cervical vertebræ except the seventh, hence the anterior surfaces of these vertebræ can be examined through the mouth. *Externally*, the chief structures are the internal carotid artery and three nerves (the glosso-pharyngeal, the vagus, and the hypo-glossal). The internal carotid artery is separated from the pharynx only by the thin constrictor muscle, hence its pulsations can readily be felt through the pharynx, and an **aneurism** of the vessel bulges into the membranous sac, the structures on the outer side of the vessel being thick and resisting its progress.

3. **Structure.**—(*a*) The **mucous membrane** is vascular and **easily inflamed** ; the inflammatory processes, once initiated, may spread to the larynx.

(*b*) **Adenoid tissue** exists in abundance in the mucous membrane, and is a frequent seat of **pharyngitis** of a scrofulous nature. A distinct tract of adenoid tissue which exists between the openings of the Eustachian tubes—Luschka's tonsil—is often enlarged.

(*c*) The **tissue outside the pharynx** is lax, hence in inflammation of the pharynx the effusion spreads rapidly, and may even reach the diaphragm ; the effusion may become purulent—**retro-pharyngeal abscess.** The pus from these abscesses (*a*) may discharge through the mouth, or, by passing behind the great vessels, (*b*) may present beneath the sterno-mastoid, or at one of the borders of that muscle. The origin of the pus is usually caries of the cervical vertebræ, but exceptionally is due to suppuration in a lymphatic gland which is situated just opposite the axis, and receives lymphatics from the nose. Suppuration may also arise as a sequel to acute pharyngitis, or owing to the breaking down of a gumma.

The **Tonsils** consist of much adenoid tissue and many mucous glands, the latter being arranged as follicles which branch and open into recesses, twelve to fifteen in number. These recesses may become filled with plugs of thickened

mucus and epithelium (**follicular tonsillitis**), a condition occasionally difficult to distinguish from diphtheria.

Relations.—Each tonsil corresponds on the surface to the angle of the jaw. On the *outer* side of the gland is the superior constrictor muscle, and outside this the ascending pharyngeal and internal carotid arteries. When enlarged the tonsils project inwards towards the middle line, but cannot be felt externally, unless enlarged from malignant disease.

Blood Supply.—(1) Tonsillar and palatine branches of facial artery ; (2) descending palatine branches of internal maxillary ; (3) dorsalis linguæ and ascending pharyngeal arteries. The operation of removal of the tonsils may be associated with serious hæmorrhage.

The **Lymphatics** pass to the deep cervical set of glands and to glands near the hyoid bone, and, in addition, to the deep parotid, and through them to the glands at the angle of the jaw. These glands would naturally become enlarged in tonsillar affections.

The Neck.

Surface Anatomy.—The **parts in the middle line** of the neck are the following :

(1) The **hyoid bone.** (2) The **thyro-hyoid membrane.** (3) The **thyroid cartilage** and the projection of its upper border—the **pomum Adami**—can be felt, and the lateral lobes of the thyroid gland are recognisable, when enlarged, on either ala. (4) The **crico-thyroid membrane.** (5) The **cricoid cartilage.**

The **sterno-mastoid muscle** is occasionally found rigidly contracted, constituting **wry neck.** The displacement of the head in this disease is threefold : (*a*) The ear of the affected side is turned towards the sterno-clavicular articulation of that side ; (*b*) the chin is rotated in such a manner as to point towards the shoulder of the sound side ; (*c*) the head is bent forwards. For the relief of 'wry neck' the surgeon may adopt the operation of **division of the sterno-mastoid.** Behind the muscle lie the carotid artery and internal jugular vein ; close to its anterior border the anterior jugular vein, afterwards passing behind, and close to its posterior border the external jugular vein. The tenotome should, therefore,

be wielded carefully, avoiding the deep surface of the muscle and its posterior border. The **spinal accessory nerve** may be divided or stretched in order to cure the same condition. The nerve is accessible at the anterior or posterior border of the sterno-mastoid ; in the former position at the level of the angle of the jaw, and in the latter about the middle of the posterior border of the muscle. The **external jugular vein** is in a line from the

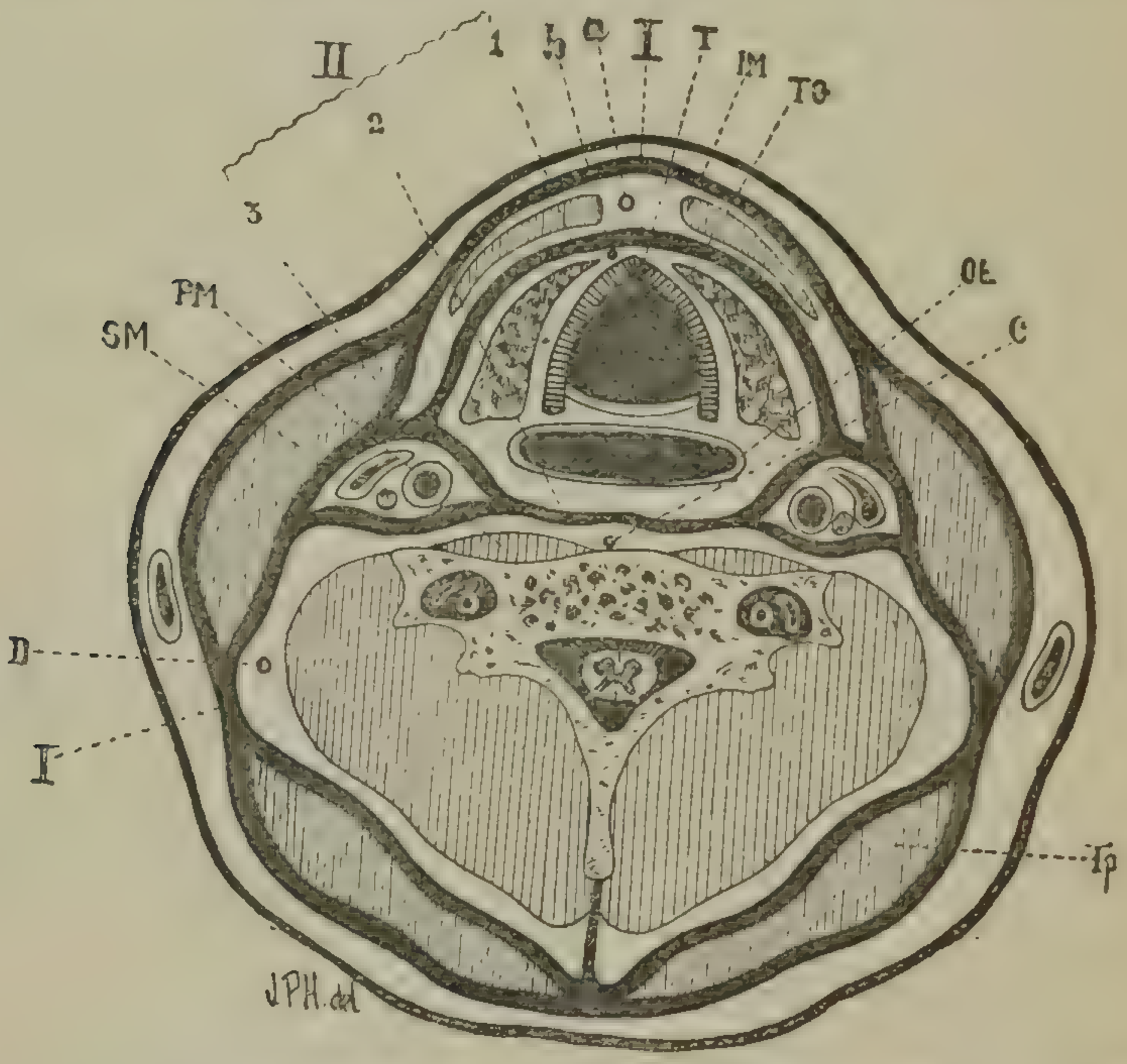

FIG. 5. — TRANSVERSE SECTION THROUGH NECK TO SHOW ARRANGEMENT OF LAYERS OF CERVICAL FASCIA (DIAGRAMMATIC ; AFTER TREVES).

angle of the jaw to the middle of the clavicle. It is occasionally necessary to faradize the **phrenic nerve**. This may be done by placing one pole over the diaphragm and the other in the centre of the supraclavicular fossa.

The Common Carotid Artery.—Extent : from behind sterno-clavicular articulation to the upper border of the thyroid cartilage. Line : from the sterno-clavicular arti-

culation to midway between the angle of the jaw and the mastoid process. Compression of the artery : best effected against the carotid tubercle, the prominent anterior tubercle of the transverse process of the sixth cervical vertebra.

Behind the sterno-clavicular joint are the following parts, from before backwards : (1) The innominate vein ; (2) the common carotid on the left side, and the division of the innominate artery on the right ; (3) the apex of the lung.

Table showing Arrangement of Deep Cervical Fascia.

The deep cervical fascia is divided into :

I. A superficial layer.

II. Deeper processes. { (1) From the superficial fascia. (2) Prævertebral fascia. (3) Carotid sheath.

I. Superficial Layer.

Transversely.	*Above.*	*Below.*
Passes completely round neck from spines of vertebræ behind to blend with fascia of opposite side in front. It is attached to the hyoid bone in the region of that bone. On its way the fascia meets with trapezius and sterno - mastoid, which it invests, and crosses posterior triangle and anterior triangle, which it covers in.	It is attached : 1. To lower border of jaw from symphysis to angle ; behind this 2. To zygoma = superficial part of parotid fascia. 3. To base of skull. From this portion of the fascia is formed the stylo - maxillary ligament. 4. To superior curved line of occiput and external occipital protuberance.	It is attached : 1. To the sternum and clavicle, being pierced by the external jugular vein just above the latter bone. 2. To the scapula.

II. Deeper Processes.

Transversely.	*Above.*	*Below.*
(1) From *superficial fascia.* Arises from the superficial fascia on deep surface of sterno-mastoid on either side, helps to invest thyroid, and assists in forming carotid sheath.	It unites with (2) to be attached to base of skull.	Is continuous with the pericardium.
(2) *Prævertebral fascia.* Lies in front of prævertebral muscles, and helps to form two sheaths, (α) the carotid, (β) the axillary, by passing downwards and outwards beneath clavicle.	Attached to base of skull.	Is continuous with prævertebral fascia.
(3) *Carotid sheath.* Formed partly from (1) and partly from (2).		

Cervical Abscesses (*vide* Fig. 5).—An abscess (*a*) between the superficial layer and process No. 1 of the deeper processes would tend to pass into the anterior mediastinum in front or into the axilla laterally. An abscess (*b*) in front of the prævertebral fascia might track into the middle mediastinum in front, or towards the apex of the pleura and lung at the side. An abscess (*c*) beneath the prævertebral fascia would burrow along the posterior mediastinum. An abscess (*d*) in the posterior triangle may extend under the clavicle until arrested by the attachment of the costo-coracoid membrane to the axillary sheath—a continuation of fascia No. 2—to the anterior and deeper parts of the neck.

Cut Throat.—The great vessels, owing to the depth at which they lie and their mobility, have occasionally escaped injury in wounds of the throat of a sufficient depth to sever the trachea or even wound the œsophagus.

Table of the Parts divided in Wounds of the Throat.

Above Hyoid Bone.	*Across Thyro-hyoid Membrane.*	*Across Trachea] (rare).*
1. Anterior jugular vein.	1. Anterior jugular vein.	1. Anterior jugular vein.
2. Muscles passing upwards from hyoid : Digastric (anterior belly). Mylo-hyoid. Genio-hyoid. Genio-hyo-glossus. Hyo-glossus.	2. Muscles : (*a*) Passing downwards from hyoid: Sterno-hyoid. Thyro-hyoid (and membrane). Omo-hyoid. (*b*) A pharyngeal muscle (inferior constrictor).	2. Muscles : Sterno-hyoid. Sterno-thyroid. Omo-hyoid. Sterno-mastoid (part of).
3. Lingual artery and nerves (lingual and hypoglossal).	3. Nerve: superior laryngeal.	3. Thyroid gland. Arteries : Superior. Inferior. Veins : Superior. Middle. Inferior.
4. Branches of the facial artery.	4. Arteries : Superior thyroid. Lingual (if near hyoid bone).	4. Recurrent nerve.
5. Submaxillary gland. *Risk:* Falling back of the tongue.	5. Pharynx. Epiglottis (if deep). *Risk:* Œdema glottidis.	5. Gullet.

The Larynx.

1. **Position.**—

Adult :
Epiglottis—third cervical vertebra.
Cricoid cartilage—sixth cervical vertebra.
Child (six years) :
Epiglottis—second cervical vertebra.
Cricoid cartilage—fifth cervical vertebra.
Infant (three months) :
Epiglottis—first cervical vertebra.
Cricoid cartilage—fourth cervical vertebra.

2. The **Rima Glottidis** is the narrowest portion of the interior of the larynx, and its level, which is, of course, that of the vocal cords, is indicated externally by the middle of the anterior margin of the thyroid cartilage (Quain). In intubation of the larynx and other intra-laryngeal operations instruments frequently require to be introduced into the rima ; the **measurements** of the opening should therefore be known. In the adult male the dimensions are nearly 1 inch from before backwards, while in breadth the aperture is from $\frac{1}{3}$ inch to $\frac{1}{2}$ inch (when dilated). In the female and the male before puberty the rima is 2 or 3 lines less.* **Foreign bodies** may lodge (1) *in the rima* (or in the upper aperture of the larynx), causing suffocation mechanically, especially with large soft bodies, as a piece of meat ; (2) *below the rima*, (either *a*) in the trachea, causing spasm of the glottis by striking against the cords during expiration, or (*b*) in the ventricle, causing no important symptoms, or (*c*) in the bronchus, becoming fixed, usually in the right bronchus, the result being loss of the respiratory murmur on the affected side.

3. The **mucous membrane** of the larynx is thickest, and the submucous tissue most abundant, principally in the upper part of the organ, hence in **acute laryngitis** there is much congestion and swelling in this district, and the seat of **œdema glottidis** is also here, more especially about the aryteno-epiglottic folds : the effusion may extend to the true vocal cords, but never below, in conse-

* 12 lines = 1 inch.

quence of the attachment of the mucous membrane directly to the cords without the intervention of submucous tissue.

The mucous glands abounding in the larynx play the principal part in the production of **clergyman's sore throat.** The disease is brought about in the following manner: In prolonged speaking the parts become dry, owing to the large amount of cold air admitted, and the function of the glands being to keep the larynx moist during phonation, they respond to the demand for increased activity, but eventually show the effects of overwork by becoming chronically inflamed. The affection is common among public speakers.

The **Trachea** is $4\frac{1}{2}$ inches long and from $\frac{3}{4}$ inch in breadth to 1 inch (at the widest part). About 2 inches of the trachea are exposed in the neck with the head straight; this is capable of being increased to $2\frac{3}{4}$ inches on full extension.

The organ is very mobile, since it is surrounded by lax connective tissue; for this reason the trachea is fixed by a sharp hook previous to the opening being made into it in the operation of tracheotomy. The trachea lies deeper and comes into closer contiguity to important structures as it descends, hence the 'high operation' is easier of performance.

Opening the Air-passages—1. **Laryngotomy.**—(1) A transverse incision is made through the crico-thyroid space, which is covered merely by integument and two layers of fascia. (2) The crico-thyroid arteries cross the space and are usually divided, but seldom cause any trouble. (3) In introducing the cannula, unless care be taken, the instrument may be pushed between the crico-thyroid membrane and the mucous membrane, instead of being made to enter the trachea.

2. **Tracheotomy**—A. *In Adults: Above Isthmus of Thyroid (High Operation).*—(1) The head is fully extended, (*a*) to give more room, (*b*) to bring the trachea nearer the surface, and (*c*) to render it less mobile. (2) An **incision** is made in the middle line—principally to avoid the numerous structures in immediate relation to the tube—through the skin and fascia (superficial and deep). The space between the sterno-hyoid and sterno-thyroid muscles is defined, and the muscles themselves

held aside. Occasionally a small vein is met with. (3) The isthmus is depressed, the trachea transfixed, and opened by dividing two or three rings from below upwards.

Through Isthmus of Thyroid.—The isthmus crosses the second, third, and fourth rings of the trachea, and is covered by a venous plexus derived from the thyroid veins of opposite sides ; it is, therefore, theoretically inadvisable to divide this structure.

Below Isthmus of Thyroid (Low Operation).—This operation is somewhat difficult for the following reasons: (1) The trachea lies deeper as it descends. (2) The isthmus runs a greater risk of injury, since the surgeon is obliged to cut towards it to avoid the important structures at the root of the neck. (3) Various structures are in the way: (*a*) **Veins**: the inferior thyroid and the anterior jugular veins, with a cross-branch between them, and occasionally the left innominate in addition, if it take an unusually high course ; (*b*) perhaps **arteries**: the 'thyroidea ima,' if it exist, and the right carotid at the lower part of the neck, if the carotids arise by a common trunk ; (*c*) the **thymus gland**, in infants.

B. *In Children* tracheotomy is the operation *par excellence*. Laryngotomy is inadmissible from the fact that the crico-thyroid space is too small to allow of the introduction of a tube of suitable dimensions. Tracheotomy is a more difficult undertaking in children than in the case of adults, because : (*a*) The infantile neck is shorter and contains more fat. (*b*) The trachea in the very young possesses several peculiarities ; it is smaller, more mobile, and it is easily collapsible. In a case reported by Dunham the collapsed and flaccid tube was held aside unknowingly, and an attempt made to open what proved to be the œsophagus. (*c*) Important structures may by their presence prove a source of difficulty ; these structures are the thymus, if well developed, and the great vessels, provided, as it not unfrequently happens, that they cross the trachea higher than in the adult.

Excision of the Larynx.—The results of partial or total excision of the larynx are not, as a rule, very satisfactory. A median incision is made, and the organ, if it is to be removed wholly, is dissected off the subjacent structures from below upwards.

The **Thyroid Body** is a ductless gland, consisting of two lobes and an isthmus. The gland extends from the middle of the thyroid cartilage to the sixth ring of the trachea. The isthmus is opposite the second, third, and fourth rings; occasionally from the left side of the isthmus a conical third lobe—the pyramid—arises. The gland is frequently subject to enlargement, constituting **bronchocele** or **goitre.**

The development of the thyroid takes place from one or more pharyngeal diverticula. In the embryo, the connection with the pharynx is represented by a duct, the 'thyreo-lingual,' and this subsequently becomes divided into a lingual duct, ending at the foramen cæcum on the tongue, and a duct connected with the thyroid—the processus pyramidalis. Either or both of these ducts may survive after fœtal life, and certain small glands and cysts in the neighbourhood of the hyoid bone are due to their persistence.

The **Relations** of the thyroid are: *Anteriorly*, the integumentary structures and deep fascia, the sterno-hyoid, sterno-thyroid, and omo-hyoid muscles. When the gland enlarges, these muscles, and the sterno-mastoid in addition, bind the gland firmly against the trachea, and this is one of the causes of the **dyspnœa** frequently observed in patients suffering from goitre; hence in such cases subcutaneous section of the muscles involved has been suggested. Sir Duncan Gibb divided the isthmus with a similar idea, viz., to 'free' the gland. *Laterally* the sheath of the carotid vessels is in relation to the thyroid, hence a goitre may receive **pulsations** from the artery, and the pressure on the internal jugular vein (and other veins) may cause a certain amount of **cerebral congestion**, evidenced by such symptoms as headache and giddiness. *Posteriorly* are the trachea and larynx, to which structures the thyroid is closely adherent; a knowledge of this fact enables the surgeon to diagnosticate bronchocele from other cervical tumours, since the former is moved up and down during deglutition. The remaining posterior relations are the lower part of the pharynx and the œsophagus (on the left side). The **dysphagia** observed in bronchocele is referable to these relations, and in addition to the fact that the laryngeal movements are handicapped by the presence of the tumour.

The recurrent laryngeal nerve may be pressed upon by an enlargement of the thyroid, causing **spasm** of the vocal cords.

The **Blood Supply** is derived from the superior and inferior thyroid arteries, and sometimes from the **thyroidea ima**. The veins form a plexus about the gland and on the front of the trachea, and from this plexus arise the superior, middle, and inferior thyroid veins.

Nerve Supply.—Derived from the vagus and the middle and inferior cervical sympathetic ganglia.

Total **excision** of the thyroid gland is followed by **myxœdema**. Probably the chief function of the gland is the production of a 'mucinoid substance,' which in the absence of the thyroid accumulates and produces swelling of the subcutaneous tissues ; this and a peculiar mental condition constitute the salient features of the disease.

The **Operation** is thus performed. (1) An incision (Y-shaped) is made through the integumentary structures, deep fascia and platysma ; the anterior jugular **veins** are divided ; the sterno-hyoid, sterno-thyroid, omo-hyoid, and a portion of the sterno-mastoid **muscles**. (2) The gland is carefully separated all round, and particular care is requisite to avoid tearing the capsule, otherwise there will be severe hæmorrhage. (3) The vessels are now secured ; 'the four arteries enter at the four corners, but the veins leave on every side, except the upper edge' (McLachlan). (4) In finally liberating the gland at its lower and posterior aspects there is some risk of injuring the recurrent laryngeal nerve. **Partial excision** of the thyroid gland may be performed.

The **Œsophagus** is about 9 inches in length, and extends from the lower border of the cricoid cartilage or sixth cervical vertebra to the cardiac end of the stomach, about the level of the ninth dorsal vertebra. The organ presents the following noticeable points :

1. **Relations.**—

In the Neck.	*In the Thorax.*
Anteriorly: Trachea, and at lower part of neck thyroid gland and thoracic duct.	*Anteriorly:* Trachea and left bronchus.
	Arteries { Arch of aorta. / Left carotid. / „ subclavian.
	Posterior surface of pericardium.
Posteriorly: Vertebræ and longi colli muscles.	*Posteriorly:* Vertebræ and longi colli muscles: aorta (near diaphragm).
Laterally: Thyroid gland, common carotid and recurrent laryngeal nerve.	*Laterally:* Pleura. On the right side is the vena azygos major. On the left side is the descending aorta.

The right vagus descends in front, the left behind the œsophagus.

2. **In passing a bougie,** the epiglottis is felt for by the left forefinger, and the bougie is then passed backwards until the posterior wall of the pharynx is touched. The instrument is then passed gently onwards, whilst the patient is instructed to swallow.

3. **Obstruction of the œsophagus** may be due to impaction of a foreign body or to **stricture** of the organ. Stricture may be either (*a*) spasmodic, (*b*) fibrous, or (*c*) malignant—usually epitheliomatous. This last variety is most commonly found either at the upper end of the œsophagus or at its lower end; it is also sometimes found where the left bronchus crosses the tube.

4. **Operations on the Œsophagus.**—*Œsophagotomy*—a temporary opening for the purpose of removing a foreign body—is thus performed: (1) The patient is placed in the dorsal position, with the head and shoulders slightly raised. (2) The **parts divided** are the skin, platysma, and if necessary the omo-hyoid. The sterno-hyoid, sterno-thyroid and carotid sheath are **drawn aside,** and the œsophagus is then exposed and opened.

Œsophagostomy—a permanent opening with the object of providing an artificial 'mouth' by which the patient

can be fed. The operation is performed in the same way as the preceding, with the exception that the edges of the œsophageal opening are stitched to the skin incision.

Pharyngotomy is performed by an incision higher than the operations mentioned above.

The **Lymphatics** are **superficial**, placed along the external jugular vein and at the lower part of the posterior triangle, and **deep** along the inner side of the carotid sheath.

CHAPTER II.

THE THORAX.

The thoracic walls are frequently deformed. In **rickets** the condition known as 'pigeon-breast' is encountered. In this disease the bones undergo a softening process, and the enfeebled ribs, unable to withstand the pressure of the atmosphere, yield at their weakest point—the junction of the sternum with the costal cartilages. The consequence of this is a pushing forward of the sternum and the appearance of a deep depression running down on either side of that bone. In conjunction with the foregoing, enlargement of the anterior ends of the ribs occurs, constituting 'rickety rosary.'

In **Lateral Curvature**, owing to the rotation of the vertebræ, the ribs on the side of the convexity bulge behind and are flattened in front, hence the ends of the ribs are nearly parallel, and the ribs on the side of the spinal concavity are sunken behind and bulging in front.

The **Sternum**, on account of its exposed position, and the fact that it is spongy in structure, is a favourite seat of **caries** and **periostitis**, usually of a gummatous nature. Its cancellous nature, though a source of danger in the foregoing respect, stands the sternum in good stead when called upon to resist shocks. The bone, moreover, rests upon a series of springs—the ribs—hence **fracture** is exceptional. When it does occur, the loss of continuity is usually at the juncture of the manubrium and the gladiolus, and is caused (*a*) by a forcible bending of the spine backwards, or (*b*) by the violent impact of the chin on the sternum.

The Ribs possess, to a considerable extent, the properties of springs, thus tending in some degree to resist fracture.

Fracture—1. **Occurrence.**—Fracture is most frequently found in the sixth, seventh, or eighth ribs, these being the most exposed; it is rarely found in the first or second ribs. The aged are more liable to the accident than the young, by reason of the ossification of the cartilages, which takes place in advanced life.

2. **Cause.**—(*a*) From *indirect violence*, by approximating the ends of the rib, the fracture taking place at the centre of the bone—the 'summit of its principal curve.' The author has encountered a case of fracture of the ribs which occurred in this manner in an insane patient while locked in an ungentle embrace with another similarly afflicted. (*b*) By *direct violence*, the fracture occurring at the site of the blow, and the fragments lacerating the pleura, and possibly the lung.

3. The **Displacement** is nil. The rib is firmly secured in front and behind, and the intercostal muscles prevent marked vertical displacement.

(1) **Paracentesis of the Thorax** is, perhaps, best performed (*a*) in the sixth or seventh space mid-way between the sternum and the spine, thus avoiding injury to the diaphragm; (*b*) the puncture is to be made at the lower margin of the selected space, since the intercostal artery takes its course along the groove at the lower border of the rib; and (*c*) with the patient taking an inspiration and bending the body away from the operator, because by this dual precaution the breadth of the intercostal space is increased.

(2) **Paracentesis of the Pericardium** may be performed in the fourth or fifth intercostal space close to the sternum, but *avoiding* the internal mammary artery.

The **Female Breast** extends from the third to the sixth rib, the position of the nipple being about the fourth rib, and 4 inches from the middle line. The gland is enveloped by a layer of superficial pectoral fascia, which splits to enclose it, and rests loosely on the pectoral muscle. In **cancer of the breast** the gland becomes adherent to the muscle. The structure of the breast is that of a compound racemose gland, composed of from fifteen to twenty separate glands, of which the ducts converge and end in the nipple; thus, in **abscess** of the breast the incisions should be made in a direction radiating from the nipple, to avoid injury, as much as is possible, to the

galactophorous ducts. Owing, also, to the contracting nature of **scirrhus**, this growth drags upon the ducts, and thus 'retraction of the nipple' takes place.

In **abscess of the breast** the pus may be (1) supra-mammary, superficial to the investing fascia; (2) intra-mammary, in the breast; and (3) submammary, behind the breast, between it and the great pectoral.

Arteries.—

1. Mammary arteries: Branches from internal mammary; external.
2. Branches from corresponding intercostal arteries over which gland is placed.
3. Long thoracic artery.

Nerves.—1. Anterior branches of second intercostal nerve.

2. Anterior and lateral branches of third, fourth, and fifth intercostal nerves. The connections of these nerves explain the fact that in affections of the breast attended with suffering the pain is widely diffused; thus, there is pain running down the arm (along intercosto-humeral, a branch of second intercostal), pain in the shoulder (branch of third intercostal to the part), and pain about the back (branches from fourth and fifth intercostal nerves to the scapula).

The majority of the **Lymphatics** of the breast proceed to the axilla (*vide infra*).

The Lungs.

1. The **Apex** of each lung rises into the neck behind the sternal end of the clavicle for 1½ to 2 inches.

2. The **Anterior Margins** of the lungs, starting from the apex, about 1½ inches above the clavicle, and rather nearer the posterior than the anterior border of the sterno-mastoid muscle—

(*a*) *Converge* until on a level with the second costal cartilage, there being very little lung behind the manubrium sterni. The parts behind this bone are:

Left innominate vein
Great primary branches of aorta } from before
Trachea } backwards.
Œsophagus

(*b*) *Are parallel*, or nearly so (and almost touch), from

the level of second costal cartilage to level of fourth costal cartilage ; then

(*c*) *Diverge* unequally :

Right Lung.	*Left Lung.*
Runs straight down to sixth chondrosternal articulation, where it slopes off along the line of the sixth right costal cartilage to its articulation with its rib.	Is notched for the heart. It passes at first *outwards* along the fourth left costal cartilage, and then *downwards* to the apex of the heart ; thence to the articulation of the sixth costal cartilage with its rib, and, lastly, follows a similar course to that of the right lung.

3. The **Lower Border** of either lung corresponds to a slightly curved line, with its convexity downwards from the articulation of the sixth costal cartilage to its rib, to the spinous process of the tenth dorsal vertebra, thus forming an intermediate border between the anterior and the posterior borders. The lower border reaches :

In the mamillary line, the sixth rib.
In the mid-axillary line, the eighth rib.
At the vertebral column, the tenth rib.

4. The **Posterior Border** of each lung, beginning where the lower border ends, viz., opposite the spine of the tenth dorsal vertebra, is represented by a line drawn from this point upwards on either side of the spinal column (corresponding to the costo-vertebral joints) until the level of the seventh cervical spinous process is reached.

The Pleura.

The **Pleura**, except at the lower border, has the same relation to the chest-walls as the lungs.

The **right pleura** in the mamillary and mid-axillary lines, and at the vertebral column, extends one rib lower than the lung—hence the seventh, ninth, and eleventh ribs respectively are reached.

The **left pleura** extends slightly lower all round than the right pleura.

The foregoing outlines of the lung are considerably altered when deep inspirations or expirations are taken.

It is evident that the pleura may be wounded while the lung escapes. In operations on the kidney it is possible to wound the serous membrane, since it is only separated from the gland by a thin layer of diaphragm. In children the pleura descends as low as the articulation of the twelfth rib with the spine.

The Heart.

1. Right Border — A line from third right costal cartilage ($\frac{1}{2}$ inch from sternum) to seventh right costal cartilage, also $\frac{1}{2}$ inch from sternum.

2. Lower Border — A line from seventh right costal cartilage to apex—2 inches below and 1 inch internal to nipple.

3. Left Border — A line from apex to third left costal cartilage—1 inch from sternum.

In mapping out the heart all these lines should be slightly curved with the convexity outwards.

4. Base ... ... — A transverse straight line across sternum, corresponding with upper borders of third costal cartilages, from $\frac{1}{2}$ inch to right of sternum to 1 inch to left of that bone.

CHAPTER III.

THE UPPER EXTREMITY.

The Region of the Shoulder.

Surface Anatomy.—The clavicle, the spinous process, and the acromion process of the scapula can be readily felt. The shoulder owes its rounded contour to the presence of the head and upper part of the humerus, in conjunction with the fibres of the deltoid. The greater tuberosity of the humerus looks in the direction of the outer condyle, the articular surface in the direction of the inner condyle ; the lesser tuberosity looks forwards and inwards, and the bicipital groove looks directly forwards. The coracoid process can be felt in the groove between the deltoid and the pectoralis major.

The Clavicle.—Fracture of the clavicle is a very common accident, and is frequently of the 'green-stick' variety ; the bone ossifying early, this accident forms a considerable percentage of the fractures of children.

Causes:—(*a*) Seldom from *direct violence ;* but if so, the bone gives way at the point struck.

(*b*) *Indirect violence* is the usual cause, the fracture taking place at the most slender part, namely, at the junction of the outer with the middle third. The fracture is oblique, and takes place from without inwards; thus we seldom meet with compound fractures of this bone, and the vessels and nerves of the neck are protected from injury, to a great extent, by the subclavius muscle.

(*c*) *Muscular action* is rarely the cause.

The **Position** may be :

(1) At the **sternal end** of the clavicle.

(2) At the junction of the two curves of the clavicle ; the outer fragment is then displaced :

Downwards by—

1. Weight of arm and scapula.
2. Muscles acting on scapula and drawing it down, viz., pectorals and latissimus dorsi.

Inwards by—

Muscles passing from trunk to shoulder, viz., trapezius, lev. ang. scap., rhomboids, latis. dorsi, and pectorals.

Forwards by—

Pectorals and serratus magnus.

(3) At coraco-clavicular ligament. Displacement nil.

(4) **Outside Coraco-Clavicular Ligament.**—The displacement affects the outer fragment, which passes forwards until at right angles to the remainder of the bone.

Excision of the Clavicle is rendered difficult because of the important **posterior relations** of the bone (subclavian vein, large nerve cords, pleura, etc.). These relations also explain the grave results which occasionally follow fractures of the clavicle, such, for instance, as **false venous aneurism** and **paralysis.**

The Sterno-Clavicular Articulation possesses surfaces which are little adapted to each other. This disadvantage is more than neutralized by the strength of the surrounding ligaments, which are of such a substantial nature as to render dislocation of this joint an uncommon accident. The articulation has an inter-articular fibro-cartilage and two separate synovial sacs. The cavity is V-shaped, with the arm hanging down, becoming a slit when raised ; hence this movement is painful in **inflammation** of the joint. This articulation is one in which ankylosis never occurs, owing to the constant movement between the surfaces.

Dislocation at the sterno-clavicular joint may be (*a*) *forwards*, the luxation being resisted by the anterior and posterior ligaments, of which the former is the weaker, and hence the forward dislocation is the commonest of the series, and hence also **effusion** presents in front ; (*b*) *backwards*, resisted by the posterior, anterior, and rhomboid ligaments. The first and last are strong bands ; hence

this form is rarer than the preceding. The clavicle may press on the structures at the root of the neck and cause **dyspnœa** and **dysphagia**, together with other pressure symptoms; (*c*) *upwards*, resisted by all the ligaments of the joint, but most directly by the rhomboid and inter-clavicular ligaments and inter-articular fibro-cartilage; hence this is the rarest dislocation. The end of the bone passes upwards and backwards, and may press on the trachea and œsophagus.

The **Acromio-Clavicular Articulation**, when **ankylosed**, lays the shoulder-joint open to the danger of a backward dislocation, since the existence of the former joint enables the scapula to move in such directions as to 'back up' the humerus when thrown forward, as in a blow 'from the shoulder.'

Supposing the glenoid cavity were unable to thus 'back' the arm, the humerus would be obliged to depend for its support on the capsular ligament of the shoulder-joint, which would be extremely liable to give way.

Dislocation of the acromio-clavicular joint is readily reduced, and returns with equal facility. The plane of the joint is downwards and inwards, hence an *upward* dislocation is the more common.

Scapula.

Fractures of this bone, and particularly of its body, are uncommon, owing to the thick muscular pads enveloping the parts, the mobility of the scapula, and the elasticity of the subjacent ribs. The fascia covering the bone is very dense and rigidly bound down, so that the **ecchymosis** observed after fracture is insignificant. The density of the fascia influences also the behaviour of **pus** in the supra and infra spinous fossæ. The fluid is pent up, and eventually obliged to present at the insertion of the subscapularis in the former case, or at the insertion of the teres minor in the latter.

Fracture may occur (1) **through the acromion process**, the most common form, and one that is frequently a separation of the epiphysis, which does not unite until the twenty-second to the twenty-fifth year; (2) **through the coracoid process**; rare; this may also be a separation of the epiphysis; (3) **through the surgical neck** (*i.e.*, from supra-scapular notch to subglenoid tubercle).

The **deformity** depends on the existence or absence of tearing of the coraco-clavicular and acromio-clavicular ligaments. If torn, the smaller fragment carrying the coracoid process will be displaced downwards with the arm, thus simulating a subglenoid dislocation of the humerus, but distinguished from this injury chiefly by observing the position of the coracoid process, which is not displaced downwards in the dislocation.

The Axilla.

1. **Relations of Contents to Walls.**—

In the *outer wall* are the large axillary vessels and nerves; in the *anterior wall* the long thoracic artery, an important vessel; in the *posterior wall* the subscapular artery; in the *inner wall* the nerve of Bell and superior thoracic artery, a small vessel, and placed high up.

In making **incisions**, therefore, into the space, the knife should be entered midway between the anterior and posterior walls of the axilla, and the surgeon should cut towards the inner wall. Hilton's method may also be employed.

2. **Abscesses** in the axilla behave as they do on account of the peculiar arrangement of the fasciæ about this region. The fasciæ are disposed as follows:

(1) The **Deep Pectoral Fascia**, which covers and encloses the pectoralis major.

(2) The **Clavi-Pectoral Fascia**, beneath the former, extends from the clavicle to the base of the axilla. On its way it fills in the space between the clavicle and the pectoralis minor; it splits to invest that muscle, and unites with the deep pectoral fascia at the anterior border of the axilla. The upper part of the clavi-pectoral fascia is known as the costo-coracoid membrane.

An **abscess** forming between these fascia (Nos. 1 and 2) would be cut off from the axilla, and would tend to present at one of two free margins, namely, either at the anterior border of the axilla, or in the groove intervening between the pectoral and deltoid muscles.

(3) The **Axillary Fascia** is formed by the two preceding fasciæ uniting, continuing on as one fascia, and stretching across the base of the axilla from its anterior to its posterior fold.

An **abscess** collecting in the axilla would be opposed in its progress in various directions: anteriorly, by the clavi-pectoral fascia and pectoral muscles; posteriorly, by the serratus magnus; to the inner side, by the thorax; to the outer side, by the arm, and below, by the axillary fascia. Above there would be little or no resistance; hence axillary abscesses have a tendency, if not dealt with surgically, to present in the neck, and they have been known to extend thence to the mediastinum.

3. The **Glands** of the axilla may be divided into three groups. (1) A **posterior group**, which is situated along the course of the subscapular artery in the posterior fold of the axilla, and receives lymphatics from the side of the chest and back, and is consequently enlarged in **tumours** of those regions. (2) An **anterior group**, along the long thoracic artery in the anterior fold of the space, receiving lymphatics from the front of the chest and the mamma; hence disease of the breast (*e.g.*, scirrhus) will be followed by enlargement of this group of glands. (3) An **external group**, along the axillary vessels, extending up into the neck to join the cervical glands, receiving lymphatics from the upper limb. Enlargement of these glands would be expected, therefore, in whitlow and various affections of the hand and arm. In removing the above glands care is necessary in order to avoid tearing the axillary vein, as the glands are frequently adherent to the vessels.

4. **Pressure on the Nerves and Vessels of Axilla.**—

On veins: Pressure on these will cause **œdema** of the hand and arm. Such a symptom occurring in a patient with cancer of the breast is of grave import, since it bears evidence to the fact that the disease has spread from its own set of glands—the anterior—and involved the deeper set along the vessels.

On arteries: The effects of pressure are not so serious as on the thinner and less resistant veins.

On nerves: The cords or branches of the brachial plexus may suffer from pressure, and paralysis result. '**Crutch palsy**' is caused by compression of the brachial nerves by the pad of a crutch. '**Saturday night palsy**' is another form, caused by pressure on the axilla, resulting from falling asleep with the arm hanging over the

back of a chair, as frequently occurs in an individual suffering from the effects of drink.

The Shoulder-Joint.

The Shoulder-Joint possesses certain **peculiarities.** (1) It is strong, by reason of its muscles only; hence dislocation and, conversely, reduction are more easily effected when the muscles are taken unawares. The long tendon of the biceps also assists in fortifying the joint. (2) The glenoid cavity is extremely shallow and the head of the humerus very large. The discrepancy in size and consequent tendency to dislocation of the joint is to some extent compensated for by the liberal range of movement thus permitted. (3) The capsule is loose, and at the lower and inner part especially thin; the rent in the capsule in dislocation, therefore, takes place at this point. The capsule affords insertion to some of the muscles surrounding the joint, and by this precaution the lax membrane escapes being pinched between the articular surfaces. (4) The synovial cavity may communicate with a large **bursa**—the **subacromial**. This, when inflamed, may simulate **chronic synovitis** of the shoulder-joint. Abduction by squeezing the bursa is, however, the only movement causing pain. The synovial cavity may also communicate with the three diverticula—(*a*) one, constant, running down the bicipital groove; (*b*) one, frequent, beneath the tendon of the subscapularis; and (*c*) one, rare, beneath the tendon of the infra-spinatus.

When **effusion** is present in the shoulder-joint, the following features are noted: (1) The capsule is evenly distended, with a bilobed projection in the situation of the bicipital diverticulum. The presence of the bicipital tendon usually causes the prominence to assume a bilobed shape. Occasionally swellings are observed in the situation of the other diverticula. (2) The position of the humerus is that in which the joint can hold most fluid, that is, extended and rotated inwards. (3) If **pus** forms, it usually escapes at one of the diverticula, especially the bicipital one. The pus may pass a good distance along the tendon.

Dislocations at the shoulder-joint are divided into

three principal forms—the subcoracoid (including the subclavicular), the subglenoid, and the subspinous.

Luxations of this joint are common, are always primarily downwards, and are usually forwards. (1) They are common because of (*a*) the disproportion between the head of the humerus and the glenoid cavity ; (*b*) the strong leverage the arm affords and its free movements ; and (*c*) the dependence of the joint on the muscles for its security. (2) They are always downwards, because dislocations occur almost invariably when the arm is abducted and the head pressing on the feeble lower part of the capsule, or, failing that, when the bone is violently forced downwards. (3) They are usually forwards ; the head of the bone is directed forward in the first instance by the attachment of the long head of the triceps. Having once got into this position, it is seized upon, as it were, by the powerful pectoral and drawn still further forwards.

A. Certain **Features** exist **Common** to all the varieties of shoulder dislocations.—(1) The normal roundness of the deltoid is due to the presence of the head of the humerus in the glenoid cavity ; the flattening of the shoulder is to be referred principally to the absence of the globular mass. (2) The deltoid and biceps are both stretched ; hence the abduction of the upper arm, and the flexion and supination of the lower. (3) Since the head of the bone descends into the axilla, it is obvious that the vertical circumference of that space will be increased. (4) The inability to touch the opposite shoulder with the fingers of the injured side, whilst the elbow of the dislocated arm touches the thorax, is characteristic of all dislocations of this joint, and is explained by the fact that, owing to the rotundity of the thorax, both ends of the bone cannot touch the chest wall at the same time when the arm is in the position described above. In a dislocation the upper end of the humerus is to all intents and purposes in immediate relation to the chest wall ; hence the lower end cannot be brought to the side. (5) Pressure symptoms are more or less common to all forms of the dislocation.

B. **Special Features.** — (1) **Subcoracoid**, the most common form. The **head of the bone** is under or slightly internal to the coracoid process. Of the **muscles,**

the subscapularis and those attached to the greater tuberosity are stretched or torn; in rare cases the tuberosity may be wrenched away. (2) **Subglenoid.** The **head of the bone** lies just in front of the origin of the long head of the triceps. Of the **muscles**, the subscapularis, supra-spinatus, and infra-spinatus are either stretched or torn, according to the degree of displacement. Another point to be noticed is that, owing to the extreme stretching of the deltoid, the arm is markedly abducted and also lengthened, the vessels usually suffering severely from pressure. (3) **Subspinous**; rare. The **capsule** may or may not be torn. The **head of the bone** lies posterior to the neck of the scapula, or, passing still further back, is found beneath the spine of that bone. Of the **muscles**, the subscapularis is torn, and the majority of the muscles surrounding the joint are rendered tense, especially the pectoralis major. The elbow is directed forward and outward. At a later date there may be paralysis of the deltoid from tearing of the circumflex nerve. In reducing old dislocations the artery suffers most frequently, owing to its external position and the liability for it to contract adhesions to the surrounding parts. The vein is injured next most commonly, and the nerve is damaged least frequently of all.

The Humerus.

The Epiphysial Lines are represented, the upper by a transverse saw cut, traversing the widest part of the upper end of the bone immediately below the great tuberosity, the lower by a line drawn across the bone directly above the level of the tips of the condyles. The epiphyses, upper and lower, unite at twenty and seventeen years respectively. These facts should be borne in mind in operating on the humerus in young persons, since injury to either epiphysis would probably be followed by arrest of growth in the bone.

In **Fractures of the Shaft** of the humerus there is a tendency to injury of the musculo-spiral nerve, and consecutive paralysis of the muscles supplied by it. Ununited fracture is common in the shaft of the bone.

This is due (*a*) to the difficulty of fixing the shoulder-joint and the upper fragment; (*b*) to the omission frequently of support to the elbow, whereby the lower fragment is dragged out of its proper line with the upper; (*c*) to the presence of small portions of muscular tissue between the ends of the broken bone.

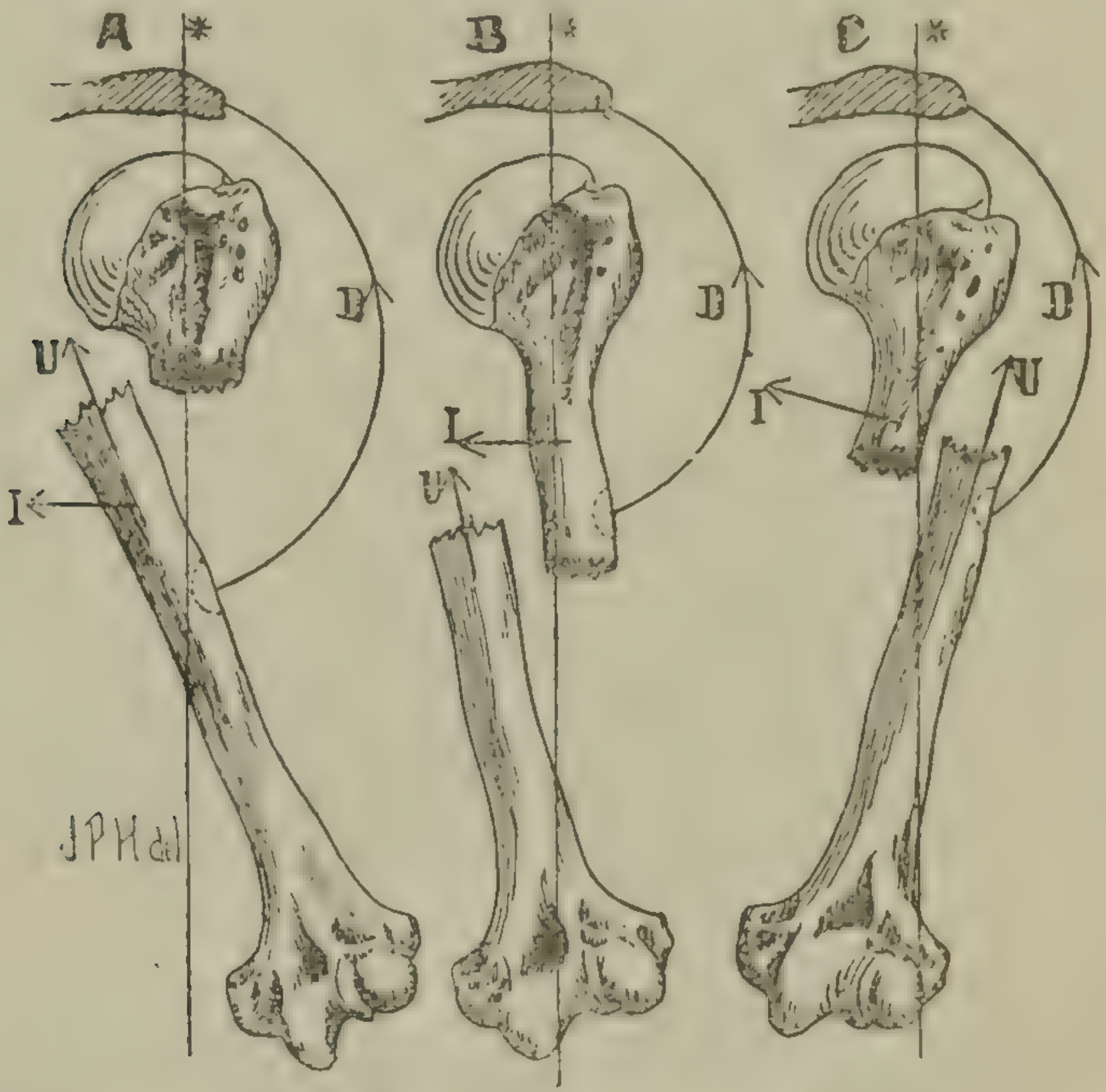

FIG. 6.—DIAGRAMS ILLUSTRATING DISPLACEMENTS OF THE FRAGMENTS IN FRACTURES OF THE HUMERUS (AFTER MCLACHLAN). * Normal line of bone. I. Forces displacing bone inwards. U. Forces displacing bone upwards. D. Action of deltoid muscle.

Table of Fractures of the Humerus.

Fracture.	*Displacement.*
1. Anatomical neck.	Very little displacement.

2. Separation of upper epiphysis.
- Upper fragment carried slightly outwards by muscles attached to greater tuberosity.
- Lower fragment drawn inwards and forwards by muscles attached to bicipital groove.

3. Surgical neck.
- Upper fragment abducted slightly by supra-spinatus (chiefly).
- Lower fragment drawn ...
  - upwards by muscles attached above biceps, triceps, coraco-brachialis;
  - inwards and forwards by pectoralis major, latissimus dorsi, teres major.

Note.—The lower end of the bone is tilted outwards by the deltoid.
The circumflex nerve may be injured.

4. Shaft :

(1) Above deltoid impression (if fracture is oblique).
- Upper fragment drawn inwards by muscles attached to bicipital groove.
- Lower fragment drawn ...
  - upwards by biceps, triceps, etc.;
  - outwards by deltoid.

(2) Below deltoid impression (if fracture is oblique).
- Upper fragment drawn outwards by deltoid.
- Lower fragment drawn upwards and inwards by biceps, triceps, and brachialis anticus.

Note.—In fractures of the shaft there is little displacement if the fracture is transverse. The musculo-spiral nerve is liable to injury.

5. Lower End :

(1) Above condyles.
- Lower fragment drawn ...
  - backwards by triceps;
  - upwards by triceps, biceps, and brachialis anticus.

Note.—The median and ulnar nerves, especially the latter, may be injured.

This fracture simulates separation of lower epiphysis, and also dislocation of radius and ulna backwards.

(2) T-shaped fracture. — A variety of (1), there being added a vertical fracture between the condyles. The displacement is the same.

(3) Inner condyle. — The fragment may be displaced upwards, backwards, and inwards. The fracture runs into the joint.

(4) Outer condyle. — This fracture also runs into the joint. Displacement practically nil. The posterior interosseous nerve may be injured.

(5) Internal epicondyle. — A separation, before eighteen years of age, of epiphysis for internal condyle; extra-articular.

(6) Separation of lower epiphysis. — Very slight displacement.

The Upper Arm.

On either side of the biceps is a depression—the inner and outer bicipital furrows. In the outer furrow we find the cephalic vein, and in the inner furrow the basilic vein, the brachial artery, the median nerve, and, in the upper part, the ulnar nerve. The insertion of the deltoid is readily found near the middle of the bone. It is an important landmark.

The Fascia of the upper arm invests the limb completely, and is divided by the intermuscular septa into anterior and posterior compartments. The septa are pierced by various structures, but they nevertheless tend to confine inflammatory and sanguineous effusions to the compartments in which they took origin.

The Brachial Artery corresponds to a line drawn from the deepest part of the middle of the axilla, down the inner side of the biceps, to the middle of the bend of the elbow (Holden). Compression of the artery is most favourably carried out midway in its course, where it

lies on the insertion of the coraco-brachialis. The direction of pressure should in the upper half of its course be inwards and a little backwards; in the lower half directly backwards.

The Musculo-Spiral Nerve arises from the posterior cord of the brachial plexus, and passing behind the brachial artery, follows the musculo-spiral groove, lying in close contact with the bone. The results of **paralysis** of this nerve are the following: (1) Drop wrist; (2) incomplete power of extending the fingers—the paralysis is not complete, as the interossei and lumbricales still retain their power; (3) diminution of the power of supination.

The Ulnar Nerve arises from the inner cord of the brachial plexus, lies to the inner side of the brachial artery, and leaves this vessel about the middle of the arm to lie eventually in the groove between the internal condyle and the olecranon with the posterior ulnar recurrent artery. The results of **paralysis** are: (1) Diminished power of flexing the ring and little fingers; (2) diminished power of flexing the wrist to the ulnar side; (3) loss of function in the interossei and two inner lumbricales; (4) loss of power to adduct the thumb, and impaired flexion of that member; (5) loss of power in the little finger and the ulnar side of the ring finger.

The Elbow.

The internal condyle is more prominent and situated higher than the external condyle. The olecranon is nearer in position to the inner than the outer condyle. In extension, the tip of the olecranon is in a line horizontally with the condyles. With the forearm flexed to a right angle, the tip of the olecranon lies below the above-mentioned line. In full flexion, the olecranon lies in front of the vertical plane of the condyles.

Superficial Veins on the front of the elbow: The median vein, running up about the centre of the forearm, divides into the median basilic vein internally and the median cephalis externally. The median cephalic is joined by the radial veins, and becomes the cephalic. The median basilic is joined by the anterior and posterior ulnar veins, and passes upwards as the basilic vein.

In **Venesection** at the bend of the elbow the surgeon usually selects the median basilic vein. It is largest, more easily compressed and fixed, and is firmly supported by the bicipital fascia, which lies posteriorly and separates the vein from the brachial artery. Venesection may be followed by certain untoward **results**: (*a*) Unless guided by a careful hand, the brachial artery is liable to be wounded, and the sequel may be false aneurism, varicose aneurism, or an aneurismal varix. (*b*) The **Lymphatics** may be infected by a dirty instrument, and septic lymphangitis occur in consequence. (*c*) **Nerves** may become implicated, resulting in neuralgia or 'bent arm,' a condition probably occasioned by injury to the filaments of the musculo-cutaneous nerve, causing reflex contraction of the biceps and brachialis anticus (Hilton). A **Lymphatic Gland** is found on the intermuscular septum a short distance above the internal condyle. It may become inflamed in poisoned wounds of the hand.

The **Anastomoses** around the elbow-joint are extremely free. Anteriorly and posteriorly to the external condyle inosculation takes place between the superior profunda and the radial recurrent and interosseous recurrent arteries. In front and behind the internal condyle, the inferior profunda and anastomotic anastomose with the anterior and posterior ulnar recurrent arteries.

The **Elbow-joint** derives its strength from the excellent adaptation of its bony surfaces. The anterior and posterior **ligaments** of the joint are comparatively thin, the lateral ligaments are stronger, and the internal lateral is the stoutest of all.

In **Acute Synovitis** (1) the joint is held semiflexed with the forearm semipronated, since in this position all the ligaments are relaxed, and the articulation is in the most favourable position for holding the largest amount of fluid. (2) The swelling appears first in the hollow on either side of the olecranon process, and may next be observed about the radio-humeral joint. (3) A mistaken diagnosis may be arrived at in cases of enlargement of the olecranon bursa—'miner's elbow'—and is to be guarded against by observing that in the latter disease the swelling is in the middle line and obscures the olecranon, whilst in synovitis it appears on either side of that process. (4) When suppuration takes place the pus finds that the

path of least resistance is upwards and backwards between the humerus and the triceps, and pointing finally takes place at one or other side of that muscle.

Dislocation at the elbow is most commonly a displacement of both bones backwards; next most frequently we meet with dislocation of the radius forwards. Lateral dislocation is rare on account of the breadth of the joint, the interlocking of the articular surfaces, and the strength of the lateral ligaments; if lateral dislocation does occur, it is usually incomplete. The position of the forearm at the moment of the reception of the injury determines, to a great extent, whether the luxation takes place in a backward or in a forward direction. If the forearm be extended the olecranon process has a good grip in the olecranon fossa, and prevents dislocation forwards, whilst if the forearm be flexed the coronoid process has a firm hold in the coronoid fossa and averts the tendency to backward dislocation. It is obvious that when one of the foregoing bony processes is firmly fixed in its fossa the other process loses in some degree its grip; thus we find that dislocation backwards takes place with the arm in the position of extension, and dislocation of the radius forwards in the position of flexion of the forearm.

Fracture of the Olecranon Process is usually due to direct violence, and separation takes place about the middle of the process, where it commences to be constricted. The displacement depends greatly on the laceration, or the reverse, of the dense fascia covering the bone. The epiphysis of the bone joins the shaft at seventeen years of age.

Resection of the Elbow may be performed in a variety of ways. There is a possibility of *danger* to the ulnar nerve, to the vessels about the bone—avoided by keeping the knife close to the bone—and to the attachment the biceps derive from the ulna, if the periosteum covering the olecranon be not preserved.

The **structures divided** when the single longitudinal vertical incision is employed are: (1) Integument; (2) Muscles: triceps, anconeus, supinator brevis, extensor carpi radialis brevior, and brachialis anticus; (3) The ligaments of the joint; (4) Bones: humerus, radius, and ulna; (5) Vessels: branches of superior and

inferior profunda, the anastomotic branch, and the radial recurrent arteries.

The *lines* of the principal arteries and nerves in the forearm may, according to Holden, be indicated as follows:

The **radial artery** corresponds with a line drawn from the outer border of the tendon of the biceps at the bend of the elbow to the front of the styloid process of the radius. The **ulnar artery** corresponds with a line running from the middle of the bend of the elbow (slightly curving to the ulnar side) to the outer side of the pisiform bone. The **median nerve** corresponds with a line drawn from the inner side of the tendon of the biceps at the elbow to the inner side of the tendon of the palmaris longus at the wrist. The **ulnar nerve** corresponds with a line drawn from the back of the internal condyle to the outer side of the pisiform bone.

Fractures of the bones of the forearm (1) are frequently greenstick. (2) Both bones are usually broken together, though Colles' fracture is also exceedingly common. (3) The fracture may occur from direct or indirect violence, and in the majority of cases is transverse; when from indirect violence the radius usually suffers; on the other hand, direct violence is generally found to have been the cause of fracture of the ulna. (4) The tendency of these fractures is to unite across the interosseous membrane; the surgeon should therefore, with one exception, set the bones with the forearm midway between pronation and supination, for in this position the bones are parallel. (5) The splints should be broader than the limb, on the one hand to prevent approximation of the bones, and on the other to avoid constriction of the forearm; the latter circumstance may, owing to the superficial position of the vessels, induce *gangrene;* flexion at the elbow-joint, by affecting the circulation through the brachial artery, also assists in bringing about this complication. The fact that the blood is returned mainly by the superficial veins is explanatory of the *œdema* frequently found in the fingers and other parts in patients wearing splints.

In fracture of **both bones** the displacement varies greatly, and is to be referred rather to the direction and nature of the force than to muscular action.

The **radius** alone may be fractured :

(1) Between the insertion of the biceps and the pronator teres.

Displacement. — *Upper Fragment :* Flexed and supinated.

Lower Fragment: Pronated and drawn towards ulna. The upper fragment being in the position of full supination, it follows that this fracture is an exception to the rule that the bones should be adjusted in splints in the mid-position between pronation and supination. If this were done the lower fragment would be in the mid-position, that is, in a different axis to the upper fragment, hence the fracture should be put up with the arm fully supinated.

(2) Between the insertion of the two pronators.

Upper fragment will probably be in the mid-position, the antagonism of the muscles being approximately equal.

Lower fragment adducted towards ulna.

The **ulna** alone may be fractured, usually about the middle of the bone, and, as mentioned above, by direct violence. The upper fragment is drawn forwards, and the lower may be carried slightly towards the radius.

Colles' Fracture is a transverse fracture of the lower end of the radius, generally about one inch above the lower articular extremity. The localization of the injury at this point is mainly in consequence of the meeting here of the cancellous tissue of the lower extremity of the bone with the compact tissue of the shaft. It is more commonly met with in females and in advanced life, and the usual history elicited is one of indirect violence — a fall on the extended palm. Should the patient fall on the dorsum of the flexed wrist a fracture the reverse of Colles' may occur (**Smith's Fracture**).

Mechanism and Displacement (Chiene). — The displacement is a triple one and affects the lower fragment only.

(1) It is **displaced backwards** (*i.e.*, antero-posteriorly), because when the palm strikes the ground the force is received principally by the ball of the thumb, whence it passes through the carpus and is transmitted to the radius. If at the moment of impact the angle the forearm makes with the ground is more than 60° (*i.e.*, approaching a

right angle), it is evident that the force will be conveyed up the forearm, and may even reach the elbow-joint, the violence expending itself, in all probability, either on the wrist-joint, producing a severe sprain of that articulation, or on the bones of the forearm, resulting in a backward dislocation. If the angle at the moment of impact is less than 60° the brunt of the force is borne by the lower end of the radius, and the bone breaks at the appropriate spot.

The effects of the force continue, and the upper fragment is forced into the lower and becomes **impacted.**

(2) It is **rotated backwards**, on an axis, which is represented by the transverse diameter of the forearm, because the posterior edge of the bone receives the greater part of the shock.

(3) It is **rotated upwards**, the rotation taking place through the inferior radio-ulnar articulation, and the consequence is that the styloid process of the radius, instead of being vertically lower than the styloid process of the ulna, is at the same or a higher level—an important diagnostic point. The fact that the radial edge of the bone receives the principal part of the shock is responsible for this rotation. It is also necessary to add that the ulnar edge of the fragment moves to a slight extent.

The Wrist and Hand.

The following are the more important points in the **Surface Anatomy** of this region.

The **Styloid Processes** of the radius and ulna are readily felt, the radial process extending further forwards, and descending lower down, than that of the ulna.

Certain **tendinous grooves** are found on the dorsum of the lower extremity of the radius. They are from without inwards as follows :

(1) A groove for the extensores ossio-metacarpi and primi internodii pollicis ; (2) A groove for the extensores carpi radialis longior and brevior : (3) A groove for the extensor secundi internodii pollicis ; (4) A groove for the extensores indicis and extensor communis digitorum ; (5) Half a groove completed by the ulna for the extensor minimi digiti.

In the **tabatière anatomique**, which is a deep depression between the second and third extensor tendons of the thumb, we can make out (1) the relief of the superficial radial vein, (2) the radial artery, (3) the upper end of the metacarpal bone of the thumb. The various visible points of interest in the **carpus** will be advantageously studied on the reader's own wrist, with the assistance of a standard work on Surface Anatomy. It is to be remembered in amputation of the fingers that the lines of the digital joints are a little nearer (about half the diameter of the finger) the ends of the finger than the projections of the knuckles.

The **Superficial Palmar Arch** crosses the palm approximately in a line with the lower border of the widely-abducted thumb, that is, about the junction of the upper with the middle third of the palm.

The **Deep Palmar Arch** lies $\frac{1}{2}$-inch higher up. The superficial palmar interosseous arteries run between the shafts of the metacarpal bones; the digital arteries on the fingers course along the sides of the sheaths.

Incisions in the palm should, if commenced at any point beyond the line of the superficial palmar arch, be made over the metacarpal bones. **Incisions to open thecal abscesses** require to be made over the middle line of the fingers.

The superficial palmar arch is composed mainly of the ulnar artery, but partly of the superficialis volæ and radialis indicis—branches of the radial. The deep palmar arch is formed mainly by the radial artery, and is completed by the deep branch of the ulnar artery.

Wounds of the palmar arches are serious, both on account of the difficulty experienced in reaching the bleeding vessel without injuring important structures, and because of the free anastomoses of the vessels concerned. Ligature of the radial or of the ulnar artery alone will not arrest hæmorrhage from either of the palmar arches, since each arch communicates with both vessels; nor will ligature of the radial and ulnar together bring about the desired result, owing to the anastomoses between the palmar arches and the interosseous vessels by means of the carpal arches.

The line of the **radio-carpal joint** is on a level with the apex of the styloid process of the ulnar.

The Palmar Fascia (1) is strong, and therefore protective to the subjacent structures. It gives slips to the fingers, and these slips despatch fibres to the digital sheaths of the tendons, to the skin, and to the superficial transverse ligament.

Dupuytren's contraction is a thickening of a chronic inflammatory character, affecting the palmar fascia, and especially its digital prolongations. The ring-finger is the first to be distorted, becoming flexed into the palm; the little finger follows suit, and it is possible for all the fingers to be affected, but the thumb invariably escapes, as there is no prolongation of the palmar fascia to that member.

(2) The palmar fascia forms three compartments in the palm: two lateral ones for the thenar and hypothenar muscles respectively, and a central space. This central compartment is roofed in by the palmar fascia, and is closed at the sides, but open above and below. Above, the space communicates, under the annular ligament, with the forearm along the flexor tendons, whilst below there are several openings communicating with the fingers. In **palmar abscess**, therefore, the pus tends to pass up into the forearm, or to track along the fingers, or even, as a *dernier ressort*, to penetrate to the dorsum of the hand, rather than pierce the dense palmar fascia and come forward. In opening such an abscess, when it points in the forearm, the incision should be made slightly to the ulnar side of the palmaris longus, thus avoiding the median nerve and the ulnar and radial arteries.

The Annular Ligaments.—1. The Anterior Annular Ligament is a powerful band of fibrous tissue, which forms a canal for the flexor tendons by arching over the groove on the anterior surface of the carpus.

Over the ligament pass the tendon of the palmaris longus and the ulnar vessels and nerve; *through* the ligament passes the tendon of the flexor carpi radialis; *under* the ligament pass the tendons of the flexors in their sheaths and the median nerve.

The **Synovial Sheaths** (Fig. 7) beneath the annular ligament are two in number—a common one for the flexor sublimis and flexor profundus digitorum, and a special one for the flexor longus pollicis. *Above*, the

common sheath extends into the forearm $1\frac{1}{4}$ inches above the annular ligament, whilst the special sheath for the flexor longus pollicis extends still further—$1\frac{1}{2}$ inches—into the forearm. *Below*, the common sheath ends in four diverticula for the fingers ; the diverticulum for the little finger is continued on to the last phalanx of that digit, but the three other processes end blindly about the middle of the corresponding metacarpal bones, and have no communication with the digital sheaths. The special sheath continues on to the last phalanx of the thumb.

The existence of these continuous channels explains the fact that **thecal abscesses** of the thumb and little finger are liable to be followed by abscess in the forearm

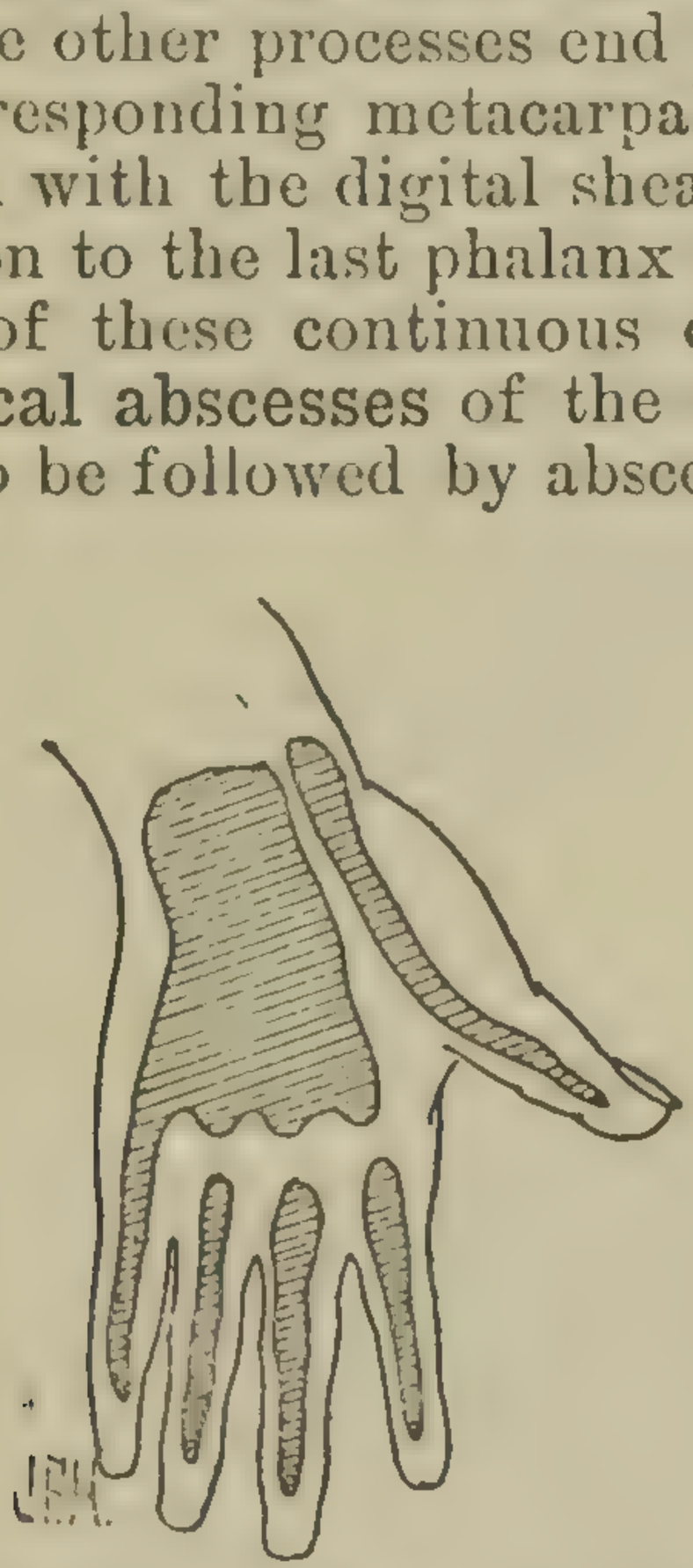

Fig. 7.—Synovial Sheaths of Palm and Fingers (Gray).

(*vide* Fig. 7), and also that a ganglion occurring in the sheaths of the flexor tendons—'compound palmar ganglion'—assumes an hour-glass shape, the constricted portion being under the annular ligament, and the dilated parts, of course, above and below this structure.

2. **The Posterior Annular Ligament** is a strong fibrous band extending tranversely across the back of the wrist, and presents six compartments for the extensor tendons, each of which compartments is lined by a separate synovial sheath.

Whitlow, a suppurative inflammation of the cellular tissue, is frequently met with in the fingers or in the

thumb. The varieties of this affection usually enumerated are: (1) An inflammation of the cutaneous structures about the root of the nail; (2) in the fibrous tissue of the pulp of the finger, which rests directly on the periosteum, without the intervention of a tendon sheath, and is therefore liable to be followed by necrosis of the terminal phalanx; (3) in the sheath of the tendon—'true thecal abscess.'

The Wrist-Joint.

1. **Dislocation.**—The wrist-joint is strong chiefly because of the powerful tendons surrounding and closely attached to it, but also on account of the contiguity of the numerous joints of the carpus, amongst which the injuring force is broken up. Dislocation of the articulation is therefore, as we should expect, uncommon. If it occur, it is usually backwards, and associated with a considerable amount of damage to the surrounding structures. Dislocation at the metacarpo-phalangeal joint of the thumb is also usually backwards, and, as a rule, gives a considerable amount of trouble in reduction. Many theories have been advanced as to the causation of this difficulty; but the probable explanation is that the head of the first metacarpal bone becomes locked between the two heads of the flexor brevis, 'like a stud between the sides of a button-hole.'

2. **Acute Synovitis.**—This may occur as the result of traumatism, or as a complication of rheumatism or other affections. The swelling strikes the observer as being most prominent on the dorsal aspect of the joint, and this principally on account of the comparative thinness of the posterior ligament. The articulation is held in a position midway between flexion and extension as the tendons on the anterior and posterior aspects of the wrist fairly balance each other. The inflammatory process not infrequently spreads to the adjacent intercarpal joints and the neighbouring tendon sheaths.

3. **Chronic Synovitis** is usually of tubercular origin. In this disease not only may the contiguous carpal joints and the tendon sheaths become involved, but the carpal bones also, leading to necrosis of those structures.

CHAPTER IV.

THE ABDOMEN.

Surface Anatomy.

1. **Abdominal Lines.**—The linea alba lies between the recti.

The **parts behind** it, from above downwards, are :

Above the Umbilicus : Liver, stomach, and transverse colon.

Below the Umbilicus : Small intestines and the bladder (when distended).

The **linea semilunaris** is a slightly curved line at the outer border of the rectus. It presents three **lineæ transversæ**, which intersect the rectus. The importance of the abdominal lines lies in the fact that they are the least vascular parts of the abdominal walls, and certain of them are therefore selected as the sites of incisions.

2. **Arteries.**—The **aorta** bifurcates about $\frac{3}{4}$ inch below, and to the left side of, the umbilicus. A more reliable guide to the level at which the artery divides is the highest point of the iliac crests, remembering at the same time that the point of bifurcation is a little to the left of the middle line. A line drawn from the bifurcation of the aorta to the point at which the pulsations of the femoral artery can be felt indicates in its upper 2 inches the **common iliac**, and in the remainder the **external iliac artery**. The **deep epigastric artery** corresponds with a line drawn from the internal ring (inner border) upwards to the middle of the rectus muscle.

3. **Bony Prominences.**—The **spine of the ilium** is readily felt, and the recognition of its relation to the

great trochanter is important in all suspected injuries of the pelvis and hips. The **spine of the pubis** is the most satisfactory guide to the external ring. The neck of the sac in the inguinal variety of hernia lies to the inner side of the prominence, and to its outer side in femoral hernia. The spine is discovered in the male by invaginating the scrotum, in the female by abducting the thigh, when the tense tendon of the adductor longus will be found to lead up to it.

4. **Abdominal Rings.**—The **external** abdominal ring is situated immediately above the spine of the pubis.

The **internal** ring is situated midway between the anterior superior spine of the ilium and the symphysis pubis, and $\frac{3}{3}$ inch above Poupart's ligament. Between these two rings the **inguinal canal** passes downwards and inwards, and its length, including the openings, is 2 inches—$1\frac{1}{2}$ inches excluding them.

The **Boundaries** of the inguinal canal are :

In front : The aponeurosis of the external oblique, and to some extent the internal oblique.

Posteriorly : The fascia transversalis and the conjoined tendon ; also the triangular ligament of the abdomen along the inner third.

Above : The arched fibres of internal oblique and transversalis.

Below : Poupart's ligament.

It is convenient to mention in this place the **femoral ring**, which is most readily found in the following way : 'Feel for the pulsations of the femoral artery on the pubes ; allow half an inch (on the inner side) for the femoral vein ; then comes the femoral ring' (Holden).

The Umbilicus.

1. The **Position** of this landmark varies, but it may usually be said to lie at about the level of the third lumbar vertebra.

2. Certain **developmental anomalies** may occur in connection with the umbilicus.

(1) It may discharge urine in subjects in whom the urachus remains patent.

(2) It may discharge faeces undes two conditions—(*a*) if Meckel's diverticulum (*i.e.*, the persistent vitelline

duct) exist and remain pervious in its whole length. This structure springs from the ilium from 1 to 3 feet above the ilio-cæcal valve, and usually is not patent in its entirety, but forms a blind tube from 2 to 3 inches in length, which, having no particular function in the economy, finds employment in snaring portions of gut; it may thus be a source of intestinal obstruction. (*b*) If the fold of intestine which occupies the cord at an early fœtal stage persists, it may be injured in tying the funis at birth, and the result be fæcal fistula. If uninjured it may still cause trouble, forming a **true congenital hernia.**

3. There may be non-union in the vicinity of the umbilicus, resulting in a **congenital exomphalos.**

4. The umbilicus and lower part of the anterior abdominal wall may be absent, together with the anterior bladder wall and symphysis pubis, constituting **extroversion of the bladder.** These deficiencies represent an extreme degree of the deformity. The penis is usually cleft along the dorsum—**epispadias.**

Abdominal Nerve Supply.

The lower seven intercostal nerves and the ilio-hypogastric (from the last lumbar) supply:

1. **The Skin of the Abdomen.**—The sixth and seventh intercostals supply the pit of the stomach; the eighth, ninth, and tenth, the skin between this and the umbilicus; the eleventh, twelfth and the ilio-hypogastric, the skin below this point. From a knowledge of these facts we can understand how **Pott's disease** of the spine, by causing pressure on these nerves, may simulate 'belly-ache' when the disease affects the upper parts, or disease of the bladder or kidneys when the lower nerves are implicated.

2. **The Abdominal Muscles.**—Thus reflex irritation of the skin causes contraction of the abdominal muscles. A practical result of this is that the muscles, warned of the first onset of danger by the skin, become rigid almost instantaneously, and protect the important organs lying subjacent.

3. The **Viscera** are to some extent supplied, and in the following way: The last seven dorsal nerves com-

municate with the lower seven sympathetic ganglia in the thorax, the splanchnic nerves come off from the lower seven or eight sympathetic ganglia, and communicate with the great plexuses supplying the viscera, and in this manner the lower seven dorsal nerves (of which the corresponding intercostal nerves are the anterior branches) help to supply the viscera as well as the abdominal muscles. The result of this arrangement is that, in injury or disease of the viscera (*e.g.*, **laceration** or **peritonitis**), the abdominal walls are reflexly kept rigid, and thus secure rest and quietude to the parts.

Inguinal Hernia (Fig. 8).

On the inner surface of the anterior abdominal wall, immediately above Poupart's ligament, are three small depressions which appear as if they had severally been produced by pressing the tip of the finger into the abdominal wall at their respective sites. They indicate three weak spots in the wall ; one of these little depressions is external to the deep epigastric artery, a second is between this artery and the obliterated hypogastric artery, while the third is internal to the latter structure.

An inguinal hernia may present at either of these 'weak spots' ; the oblique variety takes place at the most external ; and, of the direct, one form presents at the middle depression, and the other presents at the internal depression.

Hesselbach's Triangle (Fig. 8, H) has an important connection with the direct form of inguinal hernia. The space is formed—its **base** by Poupart's ligament, its **inner border** by the rectus, and its **outer border** by the deep epigastric artery. It is subdivided into two minor triangles by the obliterated hypogastric artery ; the more internal of these triangles is covered by the 'conjoined tendon' of the internal oblique and transversalis muscles, and each of the triangular spaces shows one of the 'weak spots' mentioned above.

Oblique Inguinal Hernia (Fig. 8, ⊙) enters the inguinal canal external to the deep epigastric artery ; it then occupies the whole or part of the inguinal canal, and proceeding into the scrotum, passes down in front of the cord, divorcing it from its coverings. The hernia

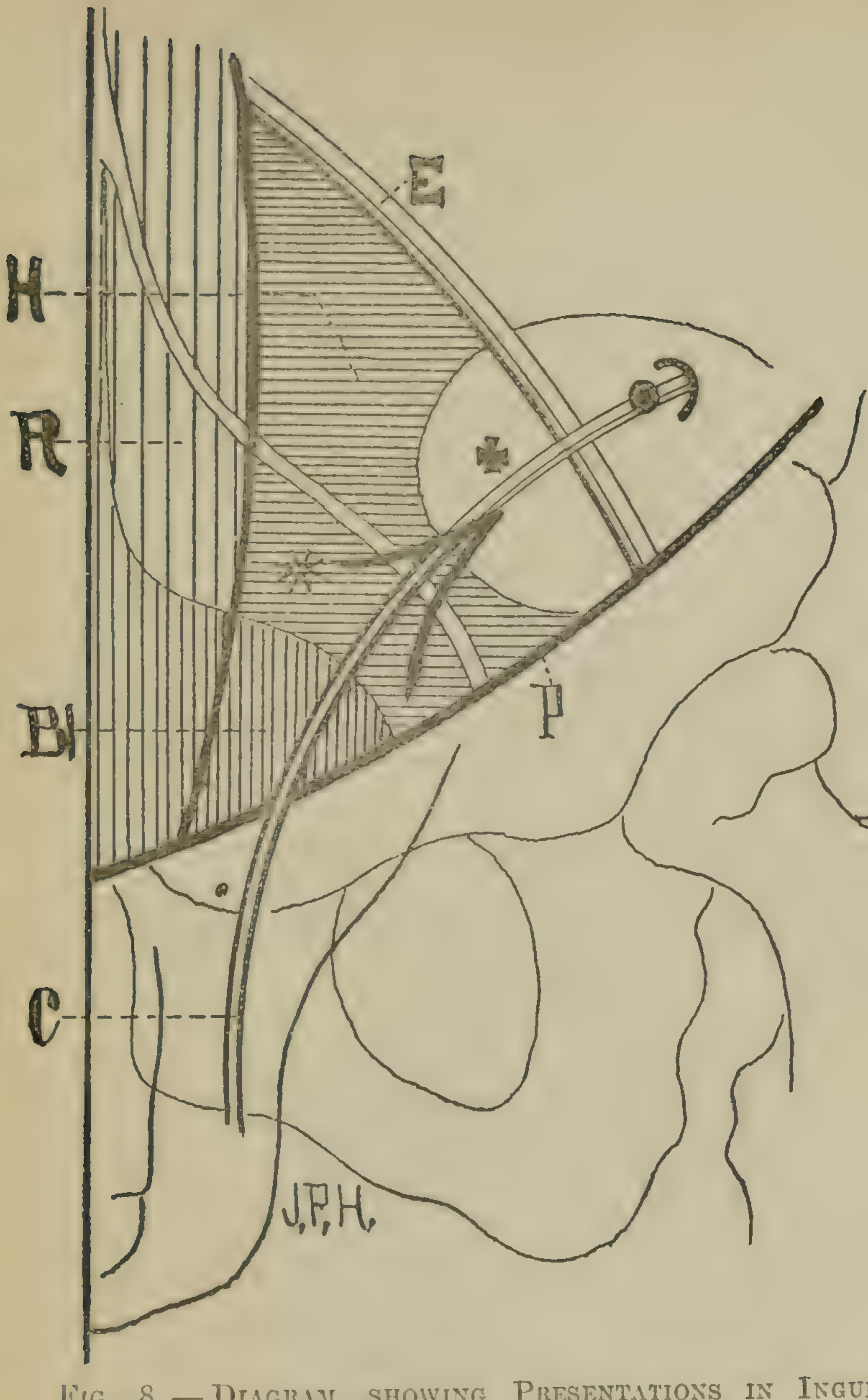

FIG. 8. — DIAGRAM SHOWING PRESENTATIONS IN INGUINAL HERNIA. H. Hesselbach's triangle. R. Rectus abdominis. P. Poupart's ligament. E. Deep epigastric artery. C. Spermatic cord. ⊙ Presentation in oblique form—external. ✣ Presentation in superior direct form—internal. * Presentation in inferior direct form—internal.

in its sac has various **coverings**. In **taxis** the thigh should be flexed and adducted, for in that position the walls of the canal are most relaxed. In **herniotomy** the constriction is best divided by an incision made **upwards**; the deep epigastric is the sole vessel in danger of being damaged.

In Direct Inguinal Hernia the gut refuses to travel down the canal from its commencement, but enters it lower down (and consequently **internal** to the deep epigastric artery) by a more direct route. There are two varieties of direct hernia: (*a*) In the **more common form** (inferior, Fig. 8, *) the herniated portion leaves the abdomen at a point internal to the obliterated hypogastric artery, and therefore, from the anatomical construction of the part, is bound to push before it or perforate the 'conjoined tendon.' (*b*) In the **second form** (superior, Fig. 8, ✝), on the other hand, the rupture quits the abdomen between the obliterated hypogastric and deep epigastric arteries, and therefore has nothing whatever to do with the 'conjoined tendon'; the **coverings** of this form are practically the same as those of the oblique hernia.

Indirect Hernia.	Direct Hernia.
1. Often congenital	Never so.
2. Axis oblique, except in old herniæ when the rings become dragged upon and the obliquity lost ...	Axis not oblique.
3. In reduction passes slightly outwards as well as backwards ...	Passes directly backwards.

The Descent of the Testicles.—Oblique inguinal hernia takes a course identical with that of the testicle in its descent, and receives similar coverings. The original seat of the testicles in fœtal life is below the kidneys and behind the peritoneum. The testicles gradually descend, and by the eighth month are making their way through the inguinal canal. By the end of the ninth month they have reached their destination at the bottom of the scrotum, to find that a process of peritoneum—the **processus vaginalis**—has arrived there before them. The glands were originally behind the peritoneum in the abdomen, so that they take up a

similar position in the scrotum ; both layers, therefore, of the serous pouch would be in front of the testicles. In some cases one or other of the glands makes a permanent stoppage at some point in the inguinal canal—retained testicle (*vide* **Testicle**). The history of the **processus vaginalis** (or funicular process) is important in relation to the causation of

Other Varieties of Inguinal Hernia (Fig. 9) than those mentioned above. The funicular process originally communicated with the general peritoneal cavity. The **upper end** (at the internal abdominal ring) is the first to close, then the **lower end** (at the upper part of the epididymis), thus cutting off the portion which never becomes effaced—the tunica vaginalis — and lastly the **middle** part along the spermatic cord.

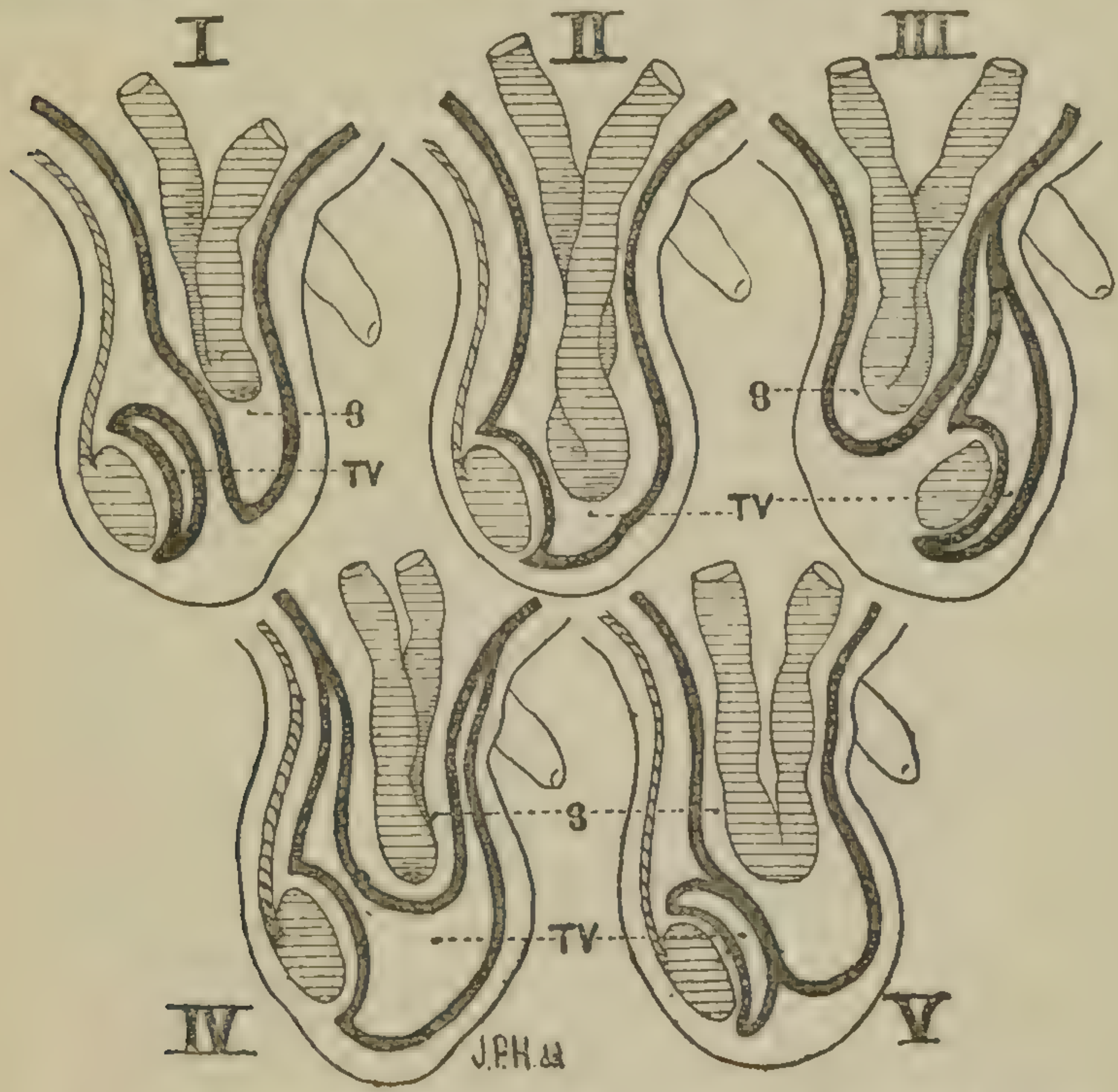

FIG. 9.—VARIETIES OF OBLIQUE INGUINAL HERNIA (GRAY). I. Common scrotal hernia. II. Congenital hernia. III. Infantile hernia. IV. Encysted hernia. V. Hernia into the funicular process.

(1) The funicular process may **fail to close** at any part; that is, above, below, or in the middle. If gut now descend into this open tube, we have the condition of **congenital hernia**; if, instead of gut, fluid collect in the pouch, **congenital hydrocele.**

(2) The funicular process may close **above** only. With this state of things two varieties of hernia are possible: (*a*) **infantile hernia**, when the rupture finds its way into the scrotum behind the unobliterated funicular process; and (*b*) **encysted hernia**, when the ruptured gut pushes before it and invaginates the occluded upper end of the pouch.

(3) The funicular process may close **below** only, the hernia descending into the *cul-de-sac* until arrested by the obliterated lower end—**funicular hernia.** If fluid collect in this space, instead of bowel descending, the condition of **hydrocele of the cord** results.

(4) Lastly, the funicular process may close **above** and **below,** but remain patent in the middle. If fluid collect in this unobliterated space, we find **encysted hydrocele of the cord.**

Femoral Hernia is invariably acquired, and more common in the female sex than in males, principally owing to the larger size of the crural canal in the former, and the weakening of the abdominal walls consequent upon pregnancy. The gut leaves the abdomen through the femoral ring and passes into the thigh along the crural canal. The structures about the ring are rigid, and the result of this is that the sac of the hernia has but a narrow neck. The direction taken by the herniated part is first downwards (for about $\frac{1}{2}$ inch), until forced to change its direction by the adhesion of the crural sheath; secondly, forwards through the saphenous opening; and, lastly, upwards, the chief cause of this movement being probably the unyielding character of the lower edge of the saphenous opening. In **taxis** the orifices of the femoral canal are rendered most lax when the thigh is flexed, adducted, and rotated inwards—hence this is the position adopted when the procedure is found necessary.

In **herniotomy** the constriction is found at Gimbernat's ligament, and the incision to relieve it should be made upwards and **inwards**, for the following reasons: (*a*) By this method both Hey's and Gimbernat's ligaments are

notched ; (*b*) if section were made in an outward direction, the femoral vein, (*c*) if upwards and outwards, the deep epigastric artery, and (*d*) if directly upwards, the spermatic cord, would be in jeopardy of being wounded. The chief danger in the operation is from the possible abnormal origin of the obturator artery, which usually arises from the internal iliac, but occasionally takes origin from the deep epigastric, in which case, in order to reach the obturator foramen, it may pass in one of two directions : (*a*) extend to the crural ring (not dangerous), or (*b*) internal to the ring (dangerous). In the latter position wounding the artery is almost unavoidable.

The following table, from McLachlan's 'Surgical Anatomy,' contrasts the equivalent coverings of the three chief forms of hernia :

Oblique Inguinal.	*Direct Inguinal.*	*Femoral.*
1. Extraperitoneal fat.	1. Extraperitoneal fat.	1. Septum crurale.
2. Fascia transversalis or infundibuliform fascia.	2. Fascia transversalis.	2. Femoral sheath
Nos. 1 and 2 constitute the 'fascia propria' of the hernia.		
3. Cremaster muscle, in series with internal oblique.	3. 'Conjoined tendon.'	3. } Cribriform fascia.
4. Intercolumnar or spermatic fascia, in series with external oblique.	4. Intercolumnar or spermatic fascia.	4. }
5. Superficial fascia.	5. Superficial fascia.	5. Superficial fascia.
6. Skin.	6. Skin.	6. Skin.

Abdominal Fasciæ.

The **Superficial Fascia** in the lower part of the abdomen is divisible into two layers—a superficial and a deep. The deep layer is the more important surgically, and is attached (*a*) in the middle line to the deeper parts as far as the symphysis pubis; (*b*) laterally it is attached a little below Poupart's ligament to the fascia lata. It has no attachment between the spine of the pubis and the symphysis, but is continued down into the scrotum as dartos; through this gap extravasated urine may reach the abdomen.

The **Transversalis Fascia** is of importance because it forms one of the coverings of inguinal hernia (the infundibuliform fascia), one of the coverings of the spermatic cord, and the anterior layer of the femoral sheath. It lines the entire abdominal wall, and is interposed between the muscles and the extraperitoneal fat; the fascia is attached below to the iliac crest, to Poupart's ligament, and to the ilio-pectineal line, and is continuous with the femoral sheath.

The **Ilio-psoas Fascia** is attached *internally* to the spinal column by a series of fibrous arches; *externally*, to the anterior layer of the fascia lumborum; *above* it forms the ligamentum arcuatum internum (a tendinous arch thrown across the upper part of the psoas muscle); *below* (iliac fascia proper) it is connected to the crest of the ilium, and, after passing over the psoas muscle, to the brim of the true pelvis and the side of the sacrum. External to the femoral vessels, this fascia is attached to Poupart's ligament with the transversalis fascia, and internal to the vessels, to the ilio-pectineal line with the same fascia. *At* the vessels it passes behind, and forms the posterior wall of the femoral sheath.

Psoas Abscess—A. **Usual Course.**—(1) Passes under the ligamentum arcuatum internum, enters the psoas sheath, and proceeds downwards as a narrow channel of pus to the iliac fossa. (2) From this fossa it does not as a rule burrow into the pelvis, because, as mentioned above, of the attachment of the fascia to the pelvic brim, but collects as a species of well in the fossa. (3) It then passes by a narrow neck under Poupart's ligament, and (4) presents at the outer side of the femoral vessels, forming another well in that position.

B. **Unusual Courses.**—Psoas abscess may leave the psoas muscle above the crest of the ilium, and, retreating backwards, point in the loin—**lumbar abscess.** Again, it may follow the guidance of the aorta and iliac vessels instead of the psoas muscle in its sheath, and present above Poupart's ligament in the inguinal region; or it may pass along the internal iliac artery to the pelvis, and, leaving that vessel, track along the gluteal artery, pass through the sacro-sciatic notch, and point in the gluteal region. Lastly, the abscess may open even on the perineum or into the bladder.

Iliac Abscess forms a swelling between the crest of the ilium and the femoral vessels, and does not tend to spread into the thigh.

The Peritoneum.

(1) The completeness of the peritoneal investment varies with different viscera, so that in some—*e.g.*, the small intestines—a wound must involve the serous membrane, while others—*e.g.*, the kidneys—are so imperfectly covered that when the organ is wounded the peritoneum usually escapes. (2) At certain parts the peritoneum is but loosely attached to adjacent structures. Over the iliac arteries, for instance, it is readily stripped off, and this circumstance is taken advantage of in the operation undertaken for the ligature of these vessels. (3) The membrane is thin in general, but in the loin and iliac fossæ becomes thick, and the scanty extraperitoneal tissue greatly increased in amount. Suppuration may take place in these situations, in **perinephritis** and in **peri-typhlitis** respectively.

The **Great Omentum**, from its position, is liable to be wounded. It is frequently found in herniæ, especially of the umbilical variety. The fold of peritoneum is apt to inflame and contract adhesions to the neighbouring parts, and the resulting bands are liable to strangulate contiguous portions of bowel.

The **Mesentery** varies in length at different parts of the intestinal canal. It is necessary for the production of both femoral and scrotal herniæ that the mesentery be elongated. This membrane, like the great omentum,

occasionally presents 'traps' for the gut. The favourite form of snare appears to be holes in the substance of the mesentery.

The Stomach.

Position.—

(*a*) *Fundus*...	Sixth left costal cartilage (below and behind apex).
(*b*) *Cardiac Orifice*	Seventh left costal cartilage one inch from junction of sternum with rib.
(*c*) *Pyloric Orifice*...	About eighth right costal cartilage, but extremely movable; may be considerably to the right of this point.
(*d*) *Lower Border* ...	A curved line from (*b*) to (*c*), reaching as low as level of tips of tenth costal cartilages.
(*e*) Portion in contact with anterior abdominal wall, and therefore accessible for opening — *triangle of Tillaux*	A triangular space. *Base:* A line drawn from tips of tenth left costal cartilage to ninth right costal cartilage. *Sides:* Lines drawn from eighth left costal cartilage to ends of base line.
(*f*) *When empty* ...	Lies at back of abdomen overlapped by liver.
When distended ...	Its greater curvature turns upwards and forwards, so that anterior surface looks upwards and posterior surface downwards, and organ is brought well against anterior abdominal wall, displacing contiguous structures, and the pylorus moves to the right.

Operations on the Stomach.—In **gastrotomy** and **gastrostomy** the stomach is opened somewhere in the triangle of Tillaux. Gastrotomy is performed with the object of making a temporary opening in order to remove a foreign body. In gastrostomy—performed in two stages with a view to causing adhesion of the viscus to the abdominal wall before opening it—a fistula is estab-

lished through which the patient can be fed. **Pylorectomy** (excision of the pylorus) may be performed in very early stages of **cancer**, before the pylorus has become adherent to the parts around; but the generally preferred operation is **gastro-enterostomy**, which consists in making 'a fistulous communication between the stomach on the cardiac side of the disease and the small intestine as high up as possible.'

The Pancreas.

The **Pancreas** is situated about two or three inches above the umbilicus, opposite the second lumbar vertebra, and behind the transverse colon. In **cancer** of the head of the organ, the usual part attacked, the common bile-duct becomes involved, and hence **persistent jaundice** results.

The other noteworthy points in reference to the gland are that it is rarely found in hernial protrusions, and then only in rare cases of diaphragmatic hernia, and that it is not to be wounded in pylorectomy, or the pancreatic juice will dissolve the cicatrix of the stomach.

The Small Intestines.

1. **Position.**—They occupy the front of the abdomen below the umbilicus, and in the adult the coils extend into the pelvis, and are therefore involved to a greater or less extent in **pelvic peritonitis**, and may become matted together in consequence. The transverse part of the duodenum crosses the spine about $1\frac{1}{2}$ inches above the umbilicus (opposite the second lumbar vertebra), and this portion of the bowel is the most fixed.

2. **Injuries.**—The mobility of the coils must sometimes avert **rupture**, but if the accident occur, the portion most frequently torn is the transverse duodenum, owing to its fixity and to the fact that it lies against the unyielding spine. In **wounds**, (*a*) if very small—a mere puncture—the peritoneal cavity is saved from extravasated fæcal matter owing to the eversion of the mucous membrane, which plugs the opening; for this reason the small bowel may be safely punctured in extreme distension from gas —**metorism**. (*b*) If larger, it is found that a longitudinal tear gapes more than a transverse one, owing to

the preponderance of the circular fibres over the longitudinal. Perforation of the duodenum may occur consecutive to ulceration of its coats, a complication which occurs in 12 per cent. of patients suffering from **burns.**

3. **Intestinal Obstruction** may be referable to the small intestines in a variety of ways : (*a*) By **strangulation by bands**, owing their formation to old peritoneal adhesions, to adherent omentum, to Meckel's diverticulum, which may cause obstruction in this manner by contracting adhesions at its distal extremity, or, lastly, owing to an adherent vermiform appendix or Fallopian tube. (*b*) By **strangulation through apertures**, normal or abnormal. The ilium is the portion of the intestinal canal usually involved in external herniæ, and such is the tendency of the small bowel to become herniated, that some part is not unfrequently involved in one or other of the various forms of internal hernia. Two varieties in which the small intestines are implicated are retro-peritoneal. One of these, **mesenteric** or retroperitoneal hernia (Cooper), is produced by the gut being pushed into a fossa formed by a pouch of peritoneum (fossa duodeno-jejunalis), which constitutes the sac of the hernia, and becomes deeper and deeper as more intestine is crowded into it. **Mesocolic** hernia (Cooper) is formed by the gut finding its way between or behind the layers of the transverse mesocolon. (*c*) By **intussusception**, which may take place at any part of the jejunum or ilium, but most commonly at the ilio-cæcal valve ; that opening forms the apex of the entering tube, and occasionally protrudes as far away from its original site as the anus. (*d*) **By other conditions**, such as stricture, impaction of fæces, and volvulus.

The Large Intestines.

Position.—The transverse colon lies in front of the pancreas two or three inches above the umbilicus. The cæcum lies in the right iliac fossa, the sigmoid flexure in the left. The ascending and descending colon lie in the right and left lumbar regions respectively, in front of the corresponding kidney. The colon is accessible to pressure throughout its course except at the hepatic and splenic flexures. It follows, therefore, that hardened fæces or

new growths in the colon are capable of being detected, under favourable circumstances, in its entire length with the exception of the splenic and hepatic flexures.

1. The **Vermiform Appendix** is 4 inches in length, is situated at the lower and posterior part of the cæcum, and has a diameter rather less than that of a goose-quill. The lodgment of foreign bodies, or other causes, may induce **inflammation** of the structure, and this may lead on to suppuration about the appendix (**perityphlitic abscess**). Other results of the inflammatory process may be **septic peritonitis** and adhesion of the appendix to neighbouring structures.

2. The **Ilio-cæcal Region** is the most frequent seat of intussusception. The circumstances which are responsible for this are the difference in calibre of the tubes meeting at this point, the fixity of the cæcum, the mobility of the ilium, and probably the sphincter-like action of the valve, its function being to prevent regurgitation of the contents of the large gut into the small.

The cæcum suffers from distension more markedly than any other part of the intestine when the large gut is obstructed.

3. **The Colon.**—The diameter of the bowel diminishes from the cæcum to the junction of the sigmoid flexure with the rectum, and at this point **stricture** is most frequently met with. From the construction of the sigmoid loop, it is not surprising to find that it is the commonest seat of **volvulus**. The sigmoid flexure forms a loop like a capital C, the narrow open part of the C corresponding to the root of the mesentery, and when this is abnormally narrow—the result of contracting peritonitis—or when the mesocolon is very lax, the flexure, usually in a loaded condition, may twist, the upper part by its weight toppling down over the lower. Chronic constipation is an important causative factor in volvulus. The looseness of the mesocolon, and, of course, the overloading with fæcal matter, are in great measure due to this habit.

The colon may be opened pathologically by an **abscess of the liver** burrowing through its coats, or by an adherent and ulcerating gall-bladder. It is opened surgically in the operation of **colotomy**.

In **Lumbar Colotomy** the descending colon is opened

in the left loin, and the peritoneal cavity is not interfered with. The line of the colon in this region is represented approximately by a line drawn vertically upwards from the centre of the crest of the ilium to the last rib. The **incision** employed is usually an oblique one 4 inches in length across the centre of this line, and parallel with the last rib. The **structures divided** are, in order: (1) Skin, superficial fascia, with cutaneous vessels and nerves, and deep fascia; (2) the posterior fibres of the external oblique and the anterior fibres of the latissimus dorsi; (3) the internal oblique; (4) the lumbar fascia and the external border of the quadratus lumborum; (5) transversalis fascia. The guides to the bowel, if the operator experiences any difficulty in finding it, are the lower end of the kidney and the outer edge of the quadratus lumborum.

In **Inguinal Colotomy** the peritoneal cavity is opened by an **incision**, nearly parallel with Poupart's ligament, two or three inches in length from a point a little above the level of the anterior superior iliac spine, downwards and forwards. The **structures divided** are the various layers of the abdominal muscles and fasciæ, and the peritoneum. Regarding the peritoneal investment of the colon, it is necessary to remark that the anterior and lateral aspects are covered by peritoneum, but the posterior surface is usually uncovered.

The Liver.

Relations.—The **upper surface** is in contact with the diaphragm. The **under surface** is in contact, on the left side, with the stomach; on the right side with the gall-bladder, duodenum, hepatic flexure of colon, right kidney, and right suprarenal capsule. The **posterior border** is in relation with the aorta, the inferior vena cava and the crura of the diaphragm; the **anterior border** either corresponds with the margin of the ribs or projects a little below it.

1. **Injuries.—Rupture** of the liver occurs more frequently than rupture of any other abdominal viscus, on account of (*a*) its large size, (*b*) its fixed position, (*c*) its friability, and (*d*) its relations to the ribs, which, if fractured, may be driven into the organ. Laceration of the liver-substance is usually fatal from hæmorrhage if

the rent extend through the peritoneal coat, chiefly because of the impossibility of contraction and retraction occurring in the hepatic veins, and the absence of valves. Rupture not involving the peritoneal coat may be recovered from.

A **stab** of the liver about the fifth, sixth, or seventh intercostal space in front would involve lung, liver, diaphragm, and pleural and peritoneal cavities. It is possible that a **hernia** of the liver may result when the organ is wounded from the front.

2. **Tumours** and enlargements of the liver partake of the respiratory movements, have no intestine in front, and will not allow fingers to be inserted between the costal margin and the tumour. The dulness is continuous with the liver dulness, and the enlargement is noticed to commence in the upper part of the abdomen.

3. **Abscess** of the liver is a common affection, and may open in various ways: (*a*) Frequently the pus is evacuated by an opening on the anterior abdominal wall; (*b*) the abscess may open into the stomach, inducing vomiting of pus; (*c*) into the lungs, and thus pus is coughed up; (*d*) into the duodenum or colon, in which case there will be pus in the fæces; (*e*) into one of the serous sacs—pleural, pericardial, or peritoneal.

The Gall-bladder.

Position.—The fundus of the gall-bladder is situated, but cannot be felt, just below the edge of the liver, about the ninth costal cartilage, and to the outer side of right rectus abdominis. The sac lies in close relation with the colon (*vide* **Colon**).

When the gall-bladder, or one of its main ducts, is **ruptured**, death is the inevitable issue, owing to the extravasated bile setting up a fatal peritonitis. The gall-bladder may suffer from **distension** from an assemblage of gall-stones in its interior, or from a collection of bile due to the blocking of one of the ducts. To relieve the condition recourse may be had to the operation of **cholecystotomy**, or opening the gall-bladder, with precautions to prevent the escape of bile into the peritoneal cavity.

The Spleen.

Position. — Lies obliquely behind ninth, tenth, and eleventh ribs, between the axillary lines continued vertically downwards. The organ cannot be felt below the ribs unless enlarged.

1. **Rupture** of the spleen, when of normal size, is uncommon, owing to its protected situation and the manner in which it is slung by its peritoneal connections. The hypertrophied organ runs a greater risk of being torn, and the injury is usually, though not necessarily, fatal from hæmorrhage ; a minute wound would be closed by the contractile power of the spleen.

2. **Enlargements and Tumours.**—The spleen may be **enlarged** from various causes ; occasionally the hypertrophied organ fills the entire abdomen and extends into the pelvis, and has been mistaken for ovarian or uterine disease. The viscus may be the seat of **tumours** and **abscesses**, which require to be treated on general surgical principles, care being taken that the pus from an abscess does not escape into the peritoneal cavity.

3. In **extirpation** of the spleen the surgeon has to guard against certain special dangers : (1) Hæmorrhage due to dragging on the gastro-splenic omentum, which causes the omental vessels to bleed ; (2) injury to the pancreas ; (3) injury to the dense plexus of sympathetic nerves in the region—a probable explanation of **persistent vomiting** following the operation.

The Kidneys.

1. **Surface Anatomy.**—The **position** of the kidneys is in the right and left lumbar regions respectively, opposite three and a half vertebræ—that is, from the last dorsal vertebra to the middle of the third lumbar vertebra ; the right kidney is about ¾ inch lower than the left. The kidney lies entirely behind the peritoneum, and is placed somewhat obliquely, the upper end inclining towards the vertebræ. Hence, in violent bending forwards of the spine the kidney fits into the bend more readily, and thus may escape being crushed. The **hilum** of the gland is opposite the first lumbar spine, and 2 inches from the middle line.

Relation to the Surface of the Body (Morris).—*Anteriorly :* (1) A horizontal line drawn through the

umbilicus is below the lower end of each kidney. (2) A vertical line drawn from the middle of Poupart's ligament, parallel with the middle line of the body, has the majority of the kidney (*i.e.*, two-thirds) to its inner side, and the remaining one-third to its outer side.

Posteriorly it is possible to mark out a four-sided space which corresponds to the position of the organ. This space is bounded (1) by a line parallel with, and one inch from, the spinous processes of five vertebræ, beginning at the eleventh dorsal spine (lower border) and ending at the third lumbar spine (lower border); (2) by a line equal to, and parallel with, the above, but $2\frac{3}{4}$ inches to the outer side; (3) by a line joining the upper ends; and (4) by a line joining the lower ends of the two foregoing lines.

2. **Injuries.** — **Rupture** of the kidney is not such a serious accident as rupture of the liver, on account of the sparse peritoneal covering which the former organ possesses; extravasated urine and blood are therefore extraperitoneal. Rupture involving the pelvis or commencement of the ureter may be followed by blocking of that duct and **hydronephrosis**.

Hæmaturia may follow a blow on the loin, and be referable to bruising of the kidney. A violent bending forwards of the body may be succeeded by a similar phenomenon, the kidney in this case suffering a severe squeeze between the crest of the ilium and the lower ribs.

3. **Abscess.** — **Perinephric abscess** may be due to disease or injury of the kidney itself, or to extension of inflammation from neighbouring parts. Such a collection of pus points, most commonly, in the lumbar region; least commonly it perforates the peritoneum. Occasionally the pus invades the iliac region, or penetrates into the pelvis. The surgeon may discover it in the pleural sac, colon, or bladder. **Renal abscess** usually opens on the non-peritoneal surface of the kidney.

4. **Floating kidney** is a congenital condition due to the existence of a mesonephron, which permits a certain mobility of the organ. **Movable kidney** is another condition in which the organ can make limited excursions, and is brought about by the absorption of the mass of perinephric fat which, with the peritoneum stretched

over it, supports the kidney. Absorption, therefore, of the fat, or undue stretching of the peritoneum—as in repeated pregnancies—may lead to the aforesaid result.

Operations on the Kidney.—(1) **Nephrotomy**, an incision into the kidney for exploratory purposes, or for the evacuation of pus. (2) **Nephro-lithotomy**, an incision into the kidney with the object of removing a calculus. (3) **Nephrectomy**, removal of the entire organ. (4) **Nephrorraphy**, the operation for securing a movable kidney.

In all these operations an incision may be employed similar to that adopted in lumbar colotomy, except that the cut is made higher up, viz., $\frac{3}{4}$ inch below the last rib (thus avoiding the pleura), and is extended further backwards.

Nephrectomy may be performed—(1) By a **lumbar** incision, as described above, and the **structures divided** are: skin, superficial and deep fascia and cutaneous nerves, the external oblique (posterior border), the latissimus dorsi (outer border), the internal oblique and the posterior aponeurosis of the transversalis muscle, the quadratus lumborum (outer border), and the transversalis aponeurosis and fascia. (2) By an **abdominal** incision, preferable when the renal growths are large, in the appropriate linea semilunaris, with its mid-point on a level with the umbilicus. The intestines being held aside, the kidney is enucleated through a rent made in the outer layer of the mesocolon.

The **Ureters** are each 15 inches long, and are placed entirely behind the peritoneum. The ureter rests on, from above downwards, (*a*) the psoas muscle and genito-crural nerve; (*b*) on the left side the common iliac, and on the right side the external iliac, vessels. (*c*) The ureter enters the posterior false ligament of the bladder, and thus arrives at the bladder wall.

The walls of the ureter are thick and muscular, nevertheless they have occasionally suffered enormous distension, even to the size of the small intestine. Rupture of the tube may occur, leading to a retroperitoneal collection of urine.

The student is strongly urged to make himself familiar with the anatomical relations of important structures throughout the body, but more especially the abdominal viscera.

CHAPTER V.

THE PELVIS AND PERINEUM.

The Pelvis.

1. **Deformities.**—In **extroversion of the bladder** the anterior part of the pelvic girdle is deficient, the symphysis pubis is absent, and the bodies of the pubic bones imperfectly developed. In **rickets** various deformities may occur, the most characteristic being a flattening of the pelvis antero-posteriorly.

2. **Fracture** of the pelvis may affect: (*a*) The false pelvis, in which case fragments are knocked off, such as a part of the iliac crest, or one or other of the spinous processes. (*b*) The true pelvis. This is a far graver accident than the preceding. The fracture usually takes place through the horizontal ramus of the pubis and the ascending ramus of the ischium; but occasionally other parts of the pelvis suffer. The acetabulum may be broken, and in patients under seventeen years of age the accident has been known to result in division of the os innominatum into its three elementary bones by separation of the Y-shaped cartilage by which they unite. **Direct** violence may cause a fracture of the pelvis if the force is applied to the weak point—that is, at the anterior part of the pelvic girdle—as in severe antero-posterior crushes of the pelvis; **indirect** violence will be responsible for the break if the force is applied laterally, the bone again giving way at the weak portion indicated above. In these pelvic injuries the adjacent important structures are imminently liable to injury; thus, the urethra, bladder, vagina, and — in fractures of the sacrum — rectum, are in danger of being lacerated or compressed.

3. **Pelvic Joints.**—The **Sacro-iliac Synchondrosis** may

be the seat of **sacro-iliac disease**, in which the joint, normally immobile, may allow (1) **movement**, due to the softened ligaments and to effusion into the joint; the articulation will also be the seat of (2) **pain**, felt whether the patient be sitting or standing, since the joint occurs in the line of the great arches through which the weight of the trunk is transmitted to the tuber ischii in a sitting posture, and to the femora in the erect position. Reflected pains are, in addition, felt in various regions, owing to the peculiar nerve relations of the joint. The nerves supplying the articulation are: (*a*) The superior gluteal nerve, hence there may be pain in the buttock in sacro-iliac disease; (*b*) the lumbo-sacral cord; the existence of this nerve, and the fact that it communicates with the great sciatic nerve, explain the occurrence in one or two reported cases of pain in the calf and the back of the thigh, referable to the disease in question; (*c*) the first sacral nerve, and (*d*) the first and second posterior sacral nerves, hence pain in the sacrum. Pain is also frequently complained of in the hip and knee joints, and along the inner side of the thigh, owing to the obturator nerve passing over the front of the sacro-iliac articulation. Lastly, in sacro-iliac disease the surgeon will find (3) **abscess formation.** The anterior ligament of the joint is the weaker, hence pus usually passes forward through this ligament and presents as an iliac abscess between the femoral vessels and the anterior superior iliac spine. Occasionally the pus may find its way into the iliac sheath; or, guided by the vessels and nerves passing through the great sacro-sciatic foramen, may penetrate into the buttock; or, directed by the obturator vessels and nerves, the pus may reach the ischio-rectal fossa. Finally, the abscess has been known to open into the gut itself.

The **Sacro-coccygeal Joint** may be dislocated or diseased, and, in either case, the continual movement of the coccyx by the muscles attached to it gives rise to great pain. The articulation may be the seat of severe neuralgia (**coccygodynia**), requiring a free incision down to the coccyx posteriorly, or excision of that bone.

The **Symphysis Pubis** has separated owing to violent muscular action, and also during the use of midwifery forceps (Oehlschläger).

Dividing the symphysis (**symphysiotomy**) to enable delivery to be effected in cases of deformed pelvis has become a recognised obstetric operation. Statistics indicate that if there is any damage done to the soft parts the injury is not, as a rule, either grave or permanent, and the life of an otherwise sacrificed child is, in the great majority of cases, saved. The operation is not justifiable in extreme pelvic contraction, or when the child is dead.

4. **Tumours.—Spina bifida** is frequently discovered in this region, and the most common position for the disease is the lumbo-sacral region, the 'neural arches of the last lumbar and all the sacral vertebræ being absent.' The varieties of spina bifida are: (1) **Spinal meningocele** (membranes of cord alone); (2) **meningo-myelocele** (membranes, cord, and nerves), the commonest form; (3) **syringo-myelocele** (membranes and cord, with its central canal dilated).

Sacro-coccygeal tumours are occasionally found.

The **Pelvic Fascia** (Fig. 10) is a thin membrane which lines the pelvic cavity, and is continuous with the transversalis and iliac fasciæ (Fig. 10, IF).

Above, the fascia is attached to the brim of the true pelvis.

In front, the membrane is thick and covers the obturator internus as low down as the 'white line,' which extends in a curved direction from the spine of the ischium to the lower part of the symphysis pubis.

Behind, the fascia is thin and covers the pyriformis muscle and sacral plexus, and allows the internal iliac vessels to perforate it.

Below (that is, at the level of the 'white line'), the fascia divides into (*a*) the recto-vesical fascia and (*b*) the obturator fascia.

(*a*) The **Recto-vesical Fascia** (Fig. 10, RV)—(visceral layer of pelvic fascia) passes from the 'white line' on one side of the pelvis, gives 'reflections' to various pelvic viscera (prostate or vagina, bladder and rectum), and reaches the 'white line' on the opposite side. These 'reflections' are arranged as follows:

1. *In front*, they form the pubo-prostatic ligaments (anterior true ligaments of bladder).

2. *Further back*, the fascia encloses the prostate and

prostatic plexus of veins, and is then continued on to the side of the bladder, forming its lateral true ligaments.

3. *Still further back*, the fascia is prolonged between the bladder and the rectum, invests the vesiculæ seminales, and reaches the other side.

(*b*) **Obturator Fascia.**—*Above*, the membrane, starting from the 'white line,' covers in the obturator internus muscle.

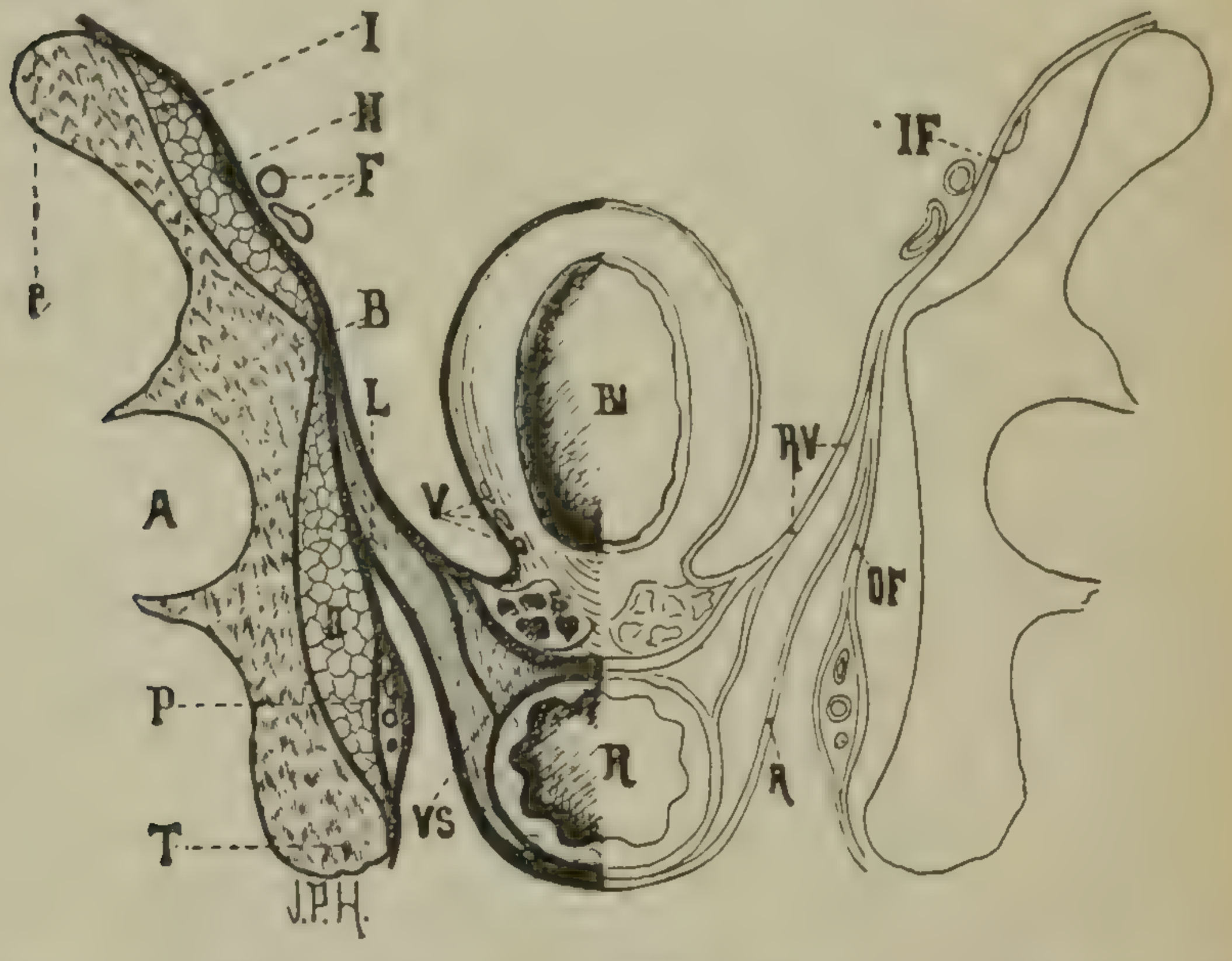

FIG. 10.—PELVIC FASCIA (AFTER GRAY). I. Iliacus. F. Obturator internus. L. Levator ani. P. Pudic vessels and nerve in Alcock's canal. VS. Vesicula seminalis. IF. Iliac fascia. RV. Recto-vesical fascia. OF. Obturator fascia. A. Anal fascia.

Below, the fascia is attached to the pubic arch and sacro-sciatic ligaments.

The obturator fascia gives off from its attachment to the rami of the pubis and the ischium a process which is continuous with a similar process from the opposite side, forming the posterior layer of the triangular ligament. This fascia forms a canal for the pudic vessels and nerves, and gives off a thin layer of fascia—anal or ischio-rectal (Fig. 10, A)—to the under surface of the levator ani.

The **Pelvic Floor** separates the perineum and ischio-rectal fossæ from the cavity of the pelvis. The structures composing the floor are, from above downwards: (1) Peritoneum; (2) extraperitoneal fat; (3) pelvic fascia; (4) muscles (levatores ani and coccygei); and triangular ligament.

Between the pelvic peritoneum and the pelvic fascia is a quantity of loose cellular tissue, which may be the seat of inflammation (**pelvic cellulitis**), that may terminate in suppuration (**pelvic abscess**).

The pelvic cellular tissue is situated (1) between the anterior wall of the bladder and the pelvis; (2) about the base and neck of the bladder; (3) between bladder and rectum, and, **in the female**, (4) between the layers of the broad ligament, and (5) about the lower part of the uterus and commencement of the vagina. Pelvic cellulitis or abscess may therefore occur in these parts, and, since the connective-tissue is continuous, inflammation in one part may spread to another. It is observed, clinically, that pelvic abscess usually presents in the inguinal region, for the progress of the pus below is resisted by the visceral pelvic fascia, and the fluid therefore tends to mount upwards.

The Male Perineum.—(1) Is a lozenge-shaped space bounded by the symphysis pubis, the rami of the pubes and ischium, the ischial tuberosities, the great sacro-sciatic ligaments, the edges of the gluteal muscles, and the coccyx. The space is divided into two triangles by a line drawn across the space between the anterior extremities of the tuber ischii, the resulting triangles being an anterior (the urethal triangle) and a posterior (the anal triangle). (2) It has the following measurements—antero-posterior, 4 inches; lateral, $3\frac{1}{2}$ inches; the depth (*i.e.*, the distance between the skin and the pelvic floor) varies with the position in the space at which the measurements are taken, and with the amount of subcutaneous fat; in the posterior and outer parts of the perineum the depth is 2 to 3 inches, in the anterior part it is less than 1 inch. (3) The perineum shows a central raphé which possesses but a slight vascularity. In this raphé, between the anus and the point of junction of the scrotum with the perineum, is the **central point of the perineum**, which (*a*) forms the meeting-place of four muscles, viz.,

the two transverse perineal, the accelerator urinæ, and the sphincter ani; (*b*) corresponds to the centre of the inferior edge of the triangular ligament; and (*c*) has the bulb and its artery just in front of it, hence the incision in lithotomy should not pass in front of the above-mentioned point.

The **Ischio-rectal Fossa** is a pyramid, with its apex at the 'white line' and its base at the skin.

1. **Boundaries.** — Outer wall: Obturator internus covered by pelvic fascia. The pudic vessels and nerves are in this wall. Inner wall: Levator ani covered by fascia. Anteriorly: Base of triangular ligament and transverse perinei muscles. Posteriorly: Gluteus maximus, great sacro-sciatic ligament, and the coccygeus.

2. **Contents of the Space.**—(1) A mass of fat badly supplied with blood. For this and other causes, such as the dependent situation of the part and its frequent exposure to damp and cold, **ischio-rectal abscess** is common. (2) Many nerves, viz., twigs of small sciatic, the inferior hæmorrhoidal nerve, the fourth sacral nerve, to the external sphincter and the superficial perineal nerves. The abundant nerve supply serves to explain the severe suffering experienced with ischio-rectal abscess. (3) The inferior hæmorrhoidal vessels.

An **ischio-rectal abscess** is hemmed in on all sides, and soon fills the fossa; it then tends to open in the directions of least resistance—that is, through the skin and through the walls of the rectum, usually within $\frac{1}{2}$ inch of the anus. The anal fascia prevents the abscess from opening into the rectum at a higher level, and it is only below the attachment of the fascia that the pus can, usually, effect an entrance.

In opening an ischio-rectal abscess, avoid, especially, injuring the rectum and the pudic and external hæmorrhoidal vessels; the danger of wounding the vessels is best obviated by cutting towards the anus, parallel with the radii of a circle of which the anus is the centre. The wisdom of this method is apparent when the fact that the vessels radiate towards the anus is considered.

The **Triangular Ligament of the Urethra** (deep perineal fascia) is attached to the pubic arch and subpubic ligament. The posterior layer of the triangular ligament is derived from the pelvic fascia.

The **deep layer of the superficial perineal fascia**, or **fascia of Colles**, is continuous in front with the dartos of the scrotum ; on each side it is firmly attached to the margins of the ischio-pubic ramus and to the tuberosity of the ischium, and posteriorly it curves round behind the transverse perineal muscles, to be attached to the lower margin of the triangular ligament.

When **extravasation of urine** takes place, as it usually does, from rupture of the membranous urethra, the urine is at first confined between the anterior and posterior layers of the triangular ligament, but afterwards finds its way through the anterior layer (where that membrane is pierced by the urethra), and then lies between the triangular ligament and the fascia of Colles ; or the fluid may find itself in this position from the first, supposing the urethra to have given way in front of the triangular ligament. Extravasated urine, then, in this situation, cannot pass backwards because of the attachment of the fascia of Colles to the base of the triangular ligament ; it cannot extend laterally on account of the attachment of both of these fasciæ to the rami of the pubes and ischium, and it cannot reach the pelvis because the triangular ligament bars the way. The pouch formed by the two foregoing layers of fascia is, however, open above, and the fluid can therefore make its way forward into the areolar tissue of the scrotum and penis, and extend thence to the anterior abdominal wall.

Lateral Lithotomy.

Incision.	*Parts cut.*	*Parts that may be wounded.*
1st. From a point $1\frac{1}{4}$ inches in front of anus, a little to left of middle line, downwards and outwards for 3 inches to between tuber ischii and anus ($\frac{1}{3}$ nearer tuber ischii).	1. Skin and superficial fascia. 2. Transverse perineal muscle, artery, and nerve. 3. Lower edge of triangular ligament — anterior layer. 4. External hæmorrhoidal vessels and nerve.	1. Bulb or its artery, avoided by commencing incision well behind central point of perineum, and by holding staff close up under pubes. 2. The rectum, if much distended. 3. The pudic vessels.
2nd. Along staff into bladder.	1. Urethra (membranous and prostatic) and compressor urethræ. 2. Triangular ligament — posterior layer. 3. Levator ani (anterior fibres) and prostate.	1. The visceral layer of pelvic fascia, avoided by making incision in prostate as limited as possible. 2. Left ejaculatory duct, if prostatic incision be carried too far back.

In operating on **children**, the following differences in structure should be borne in mind: (1) The urethra is proportionately larger; (2) the perineum is, as a rule, more vascular; (3) the prostate is rudimentary; (4) the bladder is situated higher; and (5) if the point of the knife be not raised sufficiently in making the deep part of the incision, the knife may fail to enter the bladder, and, in attempting to dilate the supposed wound in that viscus, it may be torn away from the urethra.

Median Lithotomy.

Incision.	*Parts divided.*	*Disadvantages and Advantages.*
Knife is entered in middle line, just in front of anus, and should hit the staff, which has a central groove, at apex of prostate. The whole of the membranous urethra is cut as the knife is withdrawn, and the wound in the raphé is $1\frac{1}{4}$ inches in length.	1. Skin and superficial fascia. 2. Sphincter ani. 3. Central point of perineum. 4. Triangular ligament (lower border). 5. Membranous urethra. 6. Compressor urethræ.	*Disadvantages:* 1. Bulb may be wounded, also rectum. 2. The space at the surgeon's disposal is small. 3. The operation cannot be used in the child, because there is practically no prostate, and, in addition, the bladder may be torn away from the urethra. *Advantages:* 1. Bleeding less. 2. Less danger to pelvic fascia.

In Suprapubic Lithotomy (1) the bladder and rectum are distended, and the latter organ in this state prevents the distended bladder from sinking down; (2) an incision three inches long is made in the median line immediately above, and partly over, the pubes; (3) the bladder is exposed below the peritoneum, drawn forwards with a hook, and opened. The **parts divided** are (1) the skin, (2) the superficial fascia, (3) the sheath of the recti, (4) the transversalis fascia, and (5) the bladder wall.

The **Bladder**, when **empty**, lies entirely in the pelvis, and is triangular in form; when **moderately distended** it is of a rounded form; and when fully distended it is ovoid in shape, and extends into the hypogastric, or even the umbilical, region. As the organ rises in the abdomen, it dissects off the peritoneum from the anterior

abdominal parietes, and therefore **suprapubic puncture** of the bladder is rendered feasible. Puncture of the bladder is also possible **per rectum**, the part in which the operation may be performed with safety being the external trigone, which is bounded at the sides by the diverging seminal vesicles, at the base by the recto-vesical fold of peritoneum, and at the apex by the prostate ; the trocar is driven into the bladder as near as possible to the prostate.

Peritoneal Relations of the Bladder. — *Anterior surface :* None. *Sides :* None in front or below the obliterated hypogastrics. *Posterior surface* (recto-vesical pouch) : Reaches the level of the upper end of the seminal vesicles. The peritoneal pouch is $2\frac{1}{2}$ inches from the anus when the bladder and rectum are empty ; it is distant $3\frac{1}{2}$ inches when both are full.

The **Mucous Membrane** of the bladder is lax, and thus readily accommodates itself to changes in size of the viscus, except in the region of the trigone, obviously because slackness of the mucous membrane there, would allow it to prolapse into the neck of the bladder. The trigone is important also, from the fact that the bladder, singularly insensitive over the greater part of its internal surface, is exceedingly sensitive in this region. Lastly, **calculi** gravitate towards the trigone, and the effects of **cystitis** are most marked there.

The **Muscular Coat** of the bladder is composed of interlacing bundles, which, in hypertrophy of the organ, become greatly enlarged, and constitute **fasciculated bladder** ; the intermediate tissue becomes thinned, and sacculi may form—'sacculated bladder'—and possibly lodge phosphatic or other deposits—**encysted calculi.**

The ureter runs obliquely for $\frac{3}{4}$ inch in this coat, and the direction of the tube and its environment of muscular tissue serve to prevent regurgitation of urine from the bladder.

The **Female Bladder** is less capacious than that of the male, but the neck of the organ, owing to the absence of a prostate gland, is more distensible, and usually allows of **calculi** being extracted without resorting to the **knife.**

The partition between the bladder and the vagina is thin, and liable, moreover, in parturition, to be com-

pressed between the child's head and the bony walls of the pelvis; hence **vesico-vaginal fistula** is not infrequently met with. A much commoner cause of this condition is the invasion of the bladder wall by carcinoma which has spread from the cervix, and induced sloughing of the vesico-vaginal septum, and finally fistula.

The orifice of each ureter is 3 cm. ($1\frac{1}{4}$ inches) from the cervix uteri; hence the tube is liable to injury in supra-vaginal amputation of the cervix and in certain other uterine operations.

The **Bladder of the Child** is egg-shaped, without any definite base or fundus. It is an abdominal organ, since the pelvis is small and shallow; but although situated in the abdomen, the bladder has its anterior surface entirely devoid of peritoneum.

The **Prostate Gland** resembles in shape and size an average chestnut. It is readily felt **per rectum**, and the apex of the gland can be located by the finger in the bowel. In **Cock's operation** for stricture a double-edged knife is entered just in front of the anus in the middle line of the perineum, and plunged down to the apex of the prostate—the guide to the membranous urethra, which it is desired to open.

When normal, the prostate measures $1\frac{1}{2}$ inches across at its widest part, and $1\frac{1}{4}$ inches from before backwards, and weighs about 6 drachms.

When the prostate is 2 inches from side to side, or when it weighs 1 ounce, the organ is said to be hypertrophied (Thompson).

The organ is occasionally the seat of **abscess** due to injury, gonorrhœa, or tubercle. Surrounded as it is by the dense prostatic capsule, the pus ordinarily cannot penetrate the structure, and usually discharges into the urethra, the direction of least resistance.

The prostate is frequently **enlarged**, probably in 20 per cent. of men over fifty years of age. The results of hypertrophy are: (1) The formation of a pouch behind the enlarged gland, so that urine tends to dribble away after micturition, and in many cases, also, some of the urine remains unexpelled, and forthwith decomposes and becomes ammoniacal, leading to irritation of the mucous membrane and consequent **chronic cystitis.** (2) The projecting part of the enlarged organ may overlap the

orifice of the urethra, and act like a ball-valve, preventing the urine from entering that tube. (3) The direction of the urethral tube undergoes an alteration: (*a*) if the enlargement is general, the prostatic urethra is, as one would presuppose, lengthened; (*b*) if the middle lobe be particularly affected, the prostatic urethra, normally almost straight, becomes curved; (*c*) if one or other lateral lobe be enlarged, the canal deviates to one side. Hypertrophy of the organ acts most injuriously when the middle lobe is affected, allowing a pouch to form, which becomes a cesspool for decomposing urine. For this condition,

Prostatectomy may be performed. The bladder is opened above the pubic symphysis, the mucous membrane incised, and the offending middle lobe enucleated.

The prostatic plexus of veins lies between the prostate and its capsule. The plexus is cut in lateral lithotomy, and it is in all probability through the vessels composing it that septic matter is absorbed in **pyæmia** following the operation.

The **Male Urethra** may be **ruptured** from external violence by falling astride a hard substance and striking the perineum.

The **length** of the urethra is $8\frac{1}{2}$ inches. Its **divisions** are: (1) A prostatic portion, into which the ejaculatory ducts open; hence in **gonorrhœa** inflammation may spread to the testicle, and **orchitis** result; (2) a membranous portion, the seat of **spasmodic stricture**; and (3) a spongy portion, the seat of **organic stricture**, usually just in front of the membranous urethra. The **shape** of the urethra when closed is a slit, at the anterior part vertical, further back tranverse, and in the prostatic portion of the canal curved, with the concavity downwards.

As regards the **size** of the tube, it is found to be extremely dilatable, and can usually take in the adult a No. 18 catheter without injury. Comparing the size of various parts of the canal, we find that (*a*) it is narrowest at the meatus; (*b*) it is next narrowest at the anterior layer of the triangular ligament. Very near this spot the movable and fixed portions of the urethra meet, and here, also, muscular tissue is abundant, and muscular spasm likely to take place. The concurrence at the anterior

layer of the triangular ligament of a number of difficulties to the passage of a catheter serves to explain the frequency of **false passages** in this situation 'when no stricture exists to offer a definite obstruction.' (*c*) It is wide in the fossa navicularis and in the bulbous portion, and, lastly, is widest in the centre of the prostatic portion.

The Testicle.

1. **Abnormalities in Formation.**—The testicle or the vas deferens may not be developed, or the duct may not communicate with the gland.

2. **Abnormalities in Descent.**—(*a*) The testicle may **fail to descend** absolutely or partially; that is, it may only reach the internal ring, the inguinal canal, or the external ring.

(*b*) **It may descend**, but be malplaced, the most common form of this being **inversion** of the testicle, in which the gland occupies the front instead of the back of the scrotum; the body and tunica vaginalis in this condition are posterior, whilst the epididymis looks anteriorly. **Reversion** of the testicle may also occur, in which the top of the gland is at the bottom of the scrotum, and the lower end of the gland looks, of course, upwards.

(*c*) **It may descend**, but into some abnormal position, *e.g.*, perineum or crural canal.

Spermatic Cord.

The **structures** in the spermatic cords are (1) the vas deferens, which lies along the posterior aspect of the cord; (2) the cremaster muscle; (3) arteries: spermatic, cremasteric, and the artery to the vas deferens—all these vessels are divided in the operation of **castration**, and should be secured separately; (4) the spermatic (pampiniform) plexus of veins, which are frequently varicose, constituting **varicocele**; (5) the genito-crural nerve; (6) sympathetic nerve-fibres; (7) lymphatics.

Varicocele.—The circumstances predisposing to this condition are as follows: (1) The veins of the plexus occupy a dependent position, and the main vein follows a nearly vertical course; (2) the size of the veins, in comparison with the corresponding artery, is very large, and

thus the **vis à tergo** is reduced to a minimum ; (3) the environment of the veins is not of a supporting nature, being merely a loose tissue, and they lack, moreover, the help afforded most other veins by muscular contraction ; (4) they are tortuous, anastomose freely, and their valves are neither numerous nor mechanically perfect ; and, lastly, (5) the veins are subject to pressure in their passage through the inguinal canal. It is found that left-sided varicocele is more frequent than right. For an explanation of this, we look to the facts that (*a*) the left testicle hangs lower than the right ; (*b*) the left spermatic vein enters the left renal vein at a right angle, whereas its colleague on the right side pierces the vena cava obliquely ; and (*c*) the left vein passes beneath the sigmoid flexure, and is exposed to the pressure of fæcal accumulations.

The Rectum.

1. The rectum may be the seat of various **congenital anomalies** ; thus, an infant may be born with an inconvenient deformity known as **imperforate anus** ; then, again, there may be an anus, but no rectum ; and, lastly, both anus and rectum may be present, but divided by a septum.

2. The **mucous membrane** of the bowel is loose, hence **prolapse** of the rectum is a not uncommon affection, especially in children.

3. **Piles** are frequently met with because of (*a*) the longitudinal arrangement and unsupported condition of the hæmorrhoidal vessels ; (*b*) the fact that the blood is returned from this part of the body through two distinct channels, through the systemic and through the portal systems ; thus the rectal vessels are placed, as it were, between the two, and congestion, and subsequent varicosity, encouraged ; (*c*) the absence of valves in the hæmorrhoidal veins ; (*d*) the dependent position of the rectal vessels, and their liability to be pressed upon by hardened fæces.

4. The **sphincter ani** is of surgical importance inasmuch as its constant contraction debars an ischio-rectal abscess from healing, and its reflex contractions after defecation serve to explain both the persistent pain following the act in fissure of the anus and the relief

obtained when the sphincter is stretched or partially divided.

5. The **peritoneum** leaves, first, the posterior surface of the rectum, then the sides, and lastly the anterior surface, being reflected on to the bladder in the male, or on to the vagina in the female.

In the male the recto-vesical pouch reaches to from $3\frac{1}{2}$ to 4 inches from the anus, hence it is not safe to remove more than 3 inches of the entire circumference of the bowel, but more may be removed of the posterior wall of the gut.

In the female the recto-vaginal (or Douglas') pouch extends somewhat lower, therefore remove less of the rectum than in the male. Allingham states that one inch less should be removed.

6. On **introducing the finger** into the rectum, it is possible to feel: (*a*) The membranous portion of the urethra—if a catheter has been previously introduced—exactly in the middle line; (*b*) the prostate gland; behind this (*c*) the fluctuating wall of the bladder, when distended, can be felt; (*d*) on either side, behind the prostate, can be distinguished the vesiculæ seminales, especially if enlarged from tubercular disease; (*e*) behind this the coccyx, and on the surface of the mucous membrane one or two of Houston's folds, whose use is, probably, 'to support the weight of fæcal matter, and prevent it urging towards the anus, where its presence always excites a sensation demanding its discharge;' (*f*) on either side the ischio-rectal fossæ can be felt, and the presence or absence of pus diagnosed, or the existence of a fistula discovered; (*g*) the finger is felt to be gripped by the sphincter ani for one inch up the bowel.

By gradual dilatation the whole of a moderate-sized hand can be introduced, and the descending colon reached.

CHAPTER VI.

THE LOWER EXTREMITY.

Surface Anatomy.

Poupart's ligament is a landmark that is readily discernible. The deep layer of superficial fascia, by its adhesion to this ligament, creates the **fold of the groin**; should urine be extravasated through a rupture of the membranous urethra, it is prevented from infiltrating the superficial fascia of the thigh owing to this adherence. A **furrow**, made apparent when the thigh is slightly flexed, and running outwards from the angle between the scrotum and thigh to between the top of the trochanter and the anterior superior spine of the ilium, is important, because it passes across the front of the capsule of the hip-joint. In **amputation of the thigh**, the point of the knife should be entered where this line commences externally, and should run along it and emerge where the line ends; thus the capsule is opened at the first thrust.

The **Saphenous Opening** is situated $1\frac{1}{2}$ inches below, and external to, the spine of the pubes, and is covered in by the cribriform fascia. Its outer prominent border is formed by the iliac portion of the fascia lata, and its inner depressed border by the pubic portion of that fascia.

The **Anterior Superior Spines** of the ilium are the points usually selected from which the comparative mensuration of the lower limbs is commenced.

The **Great Trochanter** leads us to the consideration of the various **test lines** which are appealed to in dislocations of the femur and fractures of the neck of the bone: (1) **Nélaton's line** is drawn from the anterior

superior spine to the tuberosity of the ischium. The top of the great trochanter should just touch this line. (2) **Bryant's triangle** consists (*a*) of a perpendicular line dropped from the anterior superior spine of the ilium straight down to the couch on which the patient is lying; (*b*) of a second line drawn at right angles to (*a*) to the top of the great trochanter; (*c*) of a third line from the top of the great trochanter to the anterior superior spine, which completes the triangle. The length of (*b*) compared with a corresponding line on the sound side shows the amount of the vertical displacement of the trochanter. (3) In **Chiene's method** two straight metal bars are placed across the body, the upper one over the anterior superior spines, and the lower opposite the tips of the great trochanters. Normally, these lines should be parallel; but if one trochanter be higher than the other, the bars will not be parallel. If a patient be asked to raise his leg, the movement will put into action and define the boundaries of **Scarpa's triangle**, viz., the sartorius, the adductor longus, and Poupart's ligament.

The **Femoral Artery** corresponds with the upper two-thirds of a line drawn from midway between the anterior superior spine of the ilium and the symphysis pubis to the tubercle for the adductor magnus. The profunda artery is given off from the femoral about $1\frac{1}{2}$ inches below Poupart's ligament.

The **Anterior Crural Nerve**, as it enters the thigh, lies about $\frac{1}{2}$ inch to the outer side of the femoral artery. When **paralyzed**, there is (*a*) inability to flex the hip completely, from paralysis of the iliacus muscle; (*b*) inability to extend the knee or the thigh, from loss of motion in the quadriceps extensor; (*c*) paralysis—complete—of the sartorius; and (*d*) paralysis—partial—of the pectineus. There is also (*e*) loss of sensation down the front and inner side of the thigh, except in the parts supplied by the crural branch of the genito-crural and by the ilio-inguinal. There is in addition loss of sensation down the inner side of the leg and foot as far as the ball of the great toe.

The **Gluteal Artery** emerges from the great sacro-sciatic foramen at the junction of the middle and upper thirds of a line drawn from the posterior superior spine of the ilium to the great trochanter.

The **Pudic** and **Sciatic Arteries** emerge from the same foramen at the junction of the middle and lower thirds of a line drawn from the posterior superior spine of the ilium to the outer part of the tuberosity of the ischium. Any of the foregoing arteries may require ligature for **wounds** or traumatic **aneurism**.

The **Great Sciatic Nerve** is in a line drawn from about midway between the great trochanter and the tuber ischii to the middle of the popliteal space. The nerve may (1) be the seat of pain—**sciatica**—from various causes. Tumours taking origin from the pelvic viscera or bones, aneurisms of branches of the internal iliac arteries, a large calculus in the bladder, or fæcal accumulation in the rectum, may all cause the condition by exerting pressure on the nerve. Among extra-pelvic causes may be included violent movements of the hip-joint, tumours growing from the margin of the sacro-sciatic foramen, and exposure to cold. (2) When, as a further result of pressure, the nerve becomes **paralyzed**, there is (*a*) loss of motive power in all the muscles below the knee; (*b*) loss of sensation over the skin area situated below the knee, except the upper half of the back of the leg (supplied by the small sciatic), and, occasionally, the upper half of the inner side of the leg, when the communicating branch of the obturator nerve is large and distributed to this part. (3) The great sciatic nerve has been **stretched** or punctured for the relief of neuralgia and other conditions. Stretching is performed by making an incision over the nerve about the centre of the thigh, **dividing** the skin, superficial structures and deep fascia, and defining the interval between the inner and outer hamstrings. The nerve is found to the inner side of the biceps.

The **dry plan** of stretching is to flex the leg on the thigh and the thigh on the abdomen, the foot being extended on the leg. With the limb in this position the leg is forcibly extended on the thigh, and the foot flexed on the leg.

The Buttocks.

The laxity of the superficial fascia in this region is such that large subcutaneous extravasations of pus or blood are permitted.

There are various **bursæ** about the buttocks. Three exist over the great trochanter, and when these are inflamed the thigh adopts the position of flexion and adduction, so as to relieve the pressure on the sacs. There is also present a bursa over the ischial tuberosity, which, when inflamed, constitutes **weaver's bottom.**

Scarpa's Triangle is a triangular space situated in the upper third of the anterior surface of the thigh, and measuring 4 inches from base to apex.

1. **Boundaries.** — Outer side : Inner border of sartorius. Inner side : Adductor longus. Base : Poupart's ligament. Apex : The crossing of the sartorius and adductor longus. Roof : Skin, superficial and deep fascia and the cribriform fascia, which closes up the saphenous opening, and is pierced by the saphenous vein. Whether the abrupt turn the vein takes over the unyielding inferior course of the opening is responsible for the condition of **varix** frequently found in the vessel is doubtful. The advocates of this theory believe that the abrupt incurvation of the vessel results in a condition of semi-strangulation. The **floor** of the space is formed from without inwards by the iliacus, psoas, pectineus, adductor brevis (sometimes), and adductor longus. This muscle may become overstretched in horsemen—**rider's sprain**—or its tendon of origin undergo ossification—**rider's bone.**

2. The **Contents** of Scarpa's triangle are : (1) the femoral sheath. (2) The femoral and profunda arteries. In this situation the **femoral artery** (*a*) is superficial, and has therefore not unfrequently been wounded. (*b*) Is easily compressed, the pressure being most conveniently brought to bear immediately below Poupart's ligament, and directed backwards to compress the vessel against the pubes and hip-capsule. If applied somewhat lower down the limb, pressure should be directed backwards and outwards against the femur. Rough pressure over the region of the artery is not without its dangers ; **phlebitis** of the femoral vein or **neuralgia** of the anterior crural nerve may ensue. (*c*) Aneurism is frequent in the common femoral, because it is just about to bifurcate into two trunks, and also because it is superficial, and thus exposed to injury, and, lastly, because the vigorous movements which take place at the hip-joint are liable to exert an injurious strain on the vessel. (3) The femoral

vein. (4) The anterior crural nerve. (5) The external cutaneous nerve, the crural branch of genito-crural nerve, and the ilio-inguinal nerve; also the obturator nerve (superficial division). (6) Fat, hence **lipomata** are not uncommon in this region.

The **Lymphatic Glands** in this region are arranged as follows:

Glands.	**Lymphatics.**
A. *Superficial* (about 10 to 15 in number).	
(i.) Horizontal set, parallel to Poupart's ligament.	Outer glands—receive outer superficial vessels of buttock. Middle glands—receive superficial vessels of lower half of abdomen. Inner glands—receive majority of inner superficial vessels of buttock; a few go to vertical set. The horizontal set of superficial glands also receive the majority of the superficial vessels from the external genitals, although a few go to the vertical set.
(ii.) Vertical set, parallel and close to saphenous vein.	Receive superficial vessels of lower limb and perineum. A few vessels from the external genitals and inner part of buttock enter this set (*vide supra*).
B. *Deep* (about 4), along the course of femoral vein.	Receive deep lymphatics of lower limb.

The Hip-joint.

The **Hip-joint** is an articulation of considerable strength, owing partly to the peculiar adaptability of the bony surfaces, and partly to the strong surrounding ligaments.

The **Ligaments** of the joint are: (1) The **Cotyloid.** (2) The **Transverse.** (3) The **Ligamentum Teres**, which is rendered tense in flexion of the thigh, with adduction or internal rotation. (4) The **Capsular** ligament, which is attached around the acetabulum above, and below to the anterior inter-trochanteric line, the base of the great

trochanter, and the middle of the posterior surface of the neck. There are certain specially thickened portions of the capsule : (*a*) The **ilio-femoral** band (Y-shaped ligament of Bigelow), which 'is attached above to the anterior inferior spine, and below the two limbs diverge—one to be attached to the upper end of the anterior inter-trochanteric line, the other to the root of the lesser tro-chanter.' Both slips limit extension, but the outer slip in addition limits eversion of the femur, therefore flexing the thigh on the trunk and rotating it inwards relax the ligament. The Y-ligament is of immense importance in dislocation of the hip. Other thickened parts of the capsule are (*b*) the **ilio-trochanteric** ligament superiorly, (*c*) the **ischio-capsular** inferiorly, and (*d*) the **pubo-femoral** in front and below ; they limit certain move-ments of the joint.

The **cervical reflection** of the capsular ligament are the deep fibres of this structure which are reflected on to the neck of the femur.

Dislocation — General Considerations. — In the **regular** forms of the dislocation—(1) All the disloca-tions are primarily downwards, but the head of the bone may ultimately assume one of a variety of situations, its particular site being determined by (*a*) the position of the limb at the time of the accident, (*b*) the presence of the Y-shaped ligament, and (*c*) the presence of the obturator internus. To understand the influence exerted by this muscle, reference should be made to a dissection of the muscles of the buttock, with the gluteus maximus removed. Bigelow states that in backward dislocations the head of the bone passes, in the first instance, in exactly the same direction whether the ultimate destina-tion be the dorsum ilii or the sciatic notch ; but in the former the head passes *between* the muscle and the pelvis, while in the latter it passes *behind* the muscle, and in consequence the tendon of the muscle arches over the neck of the bone and prevents it from passing upwards to the dorsum.

(2) The rent in the capsule takes place at its posterior and lower part.

(3) The position of the limb at the time of the accident is always one of abduction, the head pressing on the shallowest part of the acetabulum and the least supported

portion of the capsule, hence the localization of the rent in that membrane.

(4) One or both limbs of the Y-ligament are untorn in what are known as the regular dislocations of the hip, but the ligamentum teres is ruptured. The fact that the Y-ligament is untorn is taken advantage of in reducing dislocations. The ligament is used as the fulcrum of a lever, of which the long arm is the shaft of the femur and the short arm the neck of the bone.

Varieties.—(1) **On to Dorsum Ilii** (backwards and upwards). The head of the bone lies on the dorsum of the ilium, a little above and behind the acetabulum, under the glutei, and above the tendon of the obturator internus. The head takes up this position partly because it is bound to do so by the direction and nature of the force, and partly because it is pulled upwards by the glutei, hamstrings, and adductors.

Position of the limb.—Flexed (due to tension of Y-ligament); rotated inwards (due to position of head and neck, fixed by the tension of the Y-ligament). The axis of the injured thigh intersects the lower third of the sound thigh; the ball of the great toe rests on the instep of the sound foot, and there is shortening of the limb found on measurement.

(2) **Into Sciatic Notch** (backwards). The head of the bone lies on the ischium (*not* in the sciatic notch) about the level of its spine, and below the tendon of the obturator internus. This dislocation is merely a less advanced form of the preceding. The injured limb is less shortened and less flexed than in the former luxation; the knee is inverted, and touches, but does not cross, the opposite knee, and the ball of the great toe rests on the metacarpal bone of the opposite great toe.

(3) **Into Foramen Ovale** (downwards and forwards), and (4) **on Pubes** (upwards and forwards). The head of the bone in these forms lies in the thyroid foramen, or on the pubes, as the case may be.

Position of the Limb.—In the thyroid dislocation there is apparent lengthening, due to the tilting of the pelvis; in the pubic there is real shortening. There is abduction and eversion of the limb, due to the position of the head of the bone and to stretching of the external rotators and glutei; and flexion, due chiefly to stretching of the ilio-psoas.

In acute synovitis of the hip-joint the presence of fluid is not usually very apparent, but is principally detected in the anterior surface of the articulation, immediately internal to the Y-ligament ; or posteriorly, at the lower part of the joint.

Hip-joint Disease.—By this term is understood a strumous arthritis, which begins either in the bones or in the synovial membrane, usually the former. Probably the initial lesion takes place generally at the rapidly-growing edge of the epiphyseal cartilage, and when we consider the vascular nature of this structure, and the fact that injuries of the hip will commonly throw considerable strain on the part, it is not surprising that inflammation frequently supervenes.

The limb assumes certain **false positions**, which vary at the different stages.

First Stage (Inflammatory).—In this stage there is present : (1) **Flexion**, because in this position there is the greatest relaxation of structures (*ergo* the greatest ease), and the cavity holds most.

(2) **Abduction**, because this position relaxes the outer limit of the Y-ligament and the upper part of the capsule.

(3) **Eversion**, chiefly because it induces relaxation of the inner head of the Y-ligament.

(4) **Apparent lengthening**, due to tilting down of the pelvis. The rationale of the occurrence of this position is as follows : During progression in a normal subject the legs are parallel ; when, however, as the result of disease, flexion and abduction take place, the foot tends to leave the ground, and the parallelism is lost, but not irretrievably, for by tilting the pelvis downwards on the affected side the foot is again made to touch the ground, and the parallelism is restored.

(5) **Lordosis.**—The vertebræ move forward in order to minimize the inconvenience of the flexed hip. The existence of lordosis is readily discovered by placing the patient in the dorsal position on a couch, with the affected thigh flexed ; on attempting to straighten the thigh the spine is felt to arch forward in the dorsi-lumbar region.

There are in this stage other symptoms, such as pain in the knee (irritation of obturator nerve), limitation of abduction, flattening of the buttock, and obliteration of the gluteal fold.

Second Stage (Abscess Formation).—(1) **Adduction**, due, according to some authorities, to giving way of the posterior part of the capsule; according to others, to reflex spasm of the adductors (irritation of obturator nerve).

(2) **Inversion** may possibly be also due to spasm of certain muscles.

(3) **Apparent Shortening.**—This time the adductors are the offenders in upsetting the parallelism of the limbs, and to restore it the pelvis is tilted upwards, thus giving rise to the appearance of shortening.

(4) **Flexion** continues to increase until in some cases the knee may be brought into close relation with the umbilicus.

Third Stage.—There is now **real shortening**, resulting either from destruction of the femoral head and cervix, or from dislocation of the bone backwards. The top of the trochanter is discovered above Nélaton's line. Ankylosis is liable to occur in the flexed and abducted position.

The **Fascia Lata** invests the thigh like a tightly-fitting sleeve. It is attached *above* to the pubes, to Poupart's ligament, to the crest of the ilium, and to the margin of the sacrum and coccyx. *Below* it is attached to all the prominent bony points about the knee-joint; it is then continued on as the deep fascia of the leg. Therefore, **pus** collecting in the neighbourhood of the joint will tend to pass upwards in consequence of this latter attachment. The fascia is thickest at the outer part (ilio-tibial band), and in this direction the outward progress of tumours and collections of pus is checked, and thinnest on the inner side. The ilio-tibial band is found to be relaxed in fractures of the neck of the femur, *not* in dislocations.

Two deeper processes from the external and internal intermuscular septa, and these, together with the fascia lata proper, divide the thigh into three compartments.

Fracture of the Femur.

Upper End—Varieties.—1. **Fracture of the Neck**—intracapsular—(1) is usually at the junction of the head with the neck. (2) The aged are peculiarly liable to suffer from this accident, because (*a*) the angle between

the neck and the shaft lessens as age advances, (*b*) the cancellous tissue is prone to fatty degeneration, and (*c*) because of the tenuity of the compact layer in elderly people. (3) Such a fracture is rarely impacted; but if it is so, the lower fragment is driven into the upper. (4) It may be subperiosteal. (5) It rarely unites by bone if neither impacted nor subperiosteal. This unfortunate result is brought about by the fact that out of the three sources of blood supply to the head of the femur (through the neck, the reflected capsule, and the ligamentum teres) only one remains available—that through the ligamentum teres.

2. **Fracture of the Neck at Base**—partly intracapsular and partly extracapsular. A wholly extracapsular fracture of the neck is anatomically impossible, because of the fact that the capsule is attached to a portion of the intertrochanteric line, where it strictly follows the junction of the neck with the shaft. A wholly extracapsular fracture may involve the neck posteriorly, but is bound to implicate a portion of the shaft in front. When impacted, the upper fragment, unlike the foregoing fracture, is driven into the lower, and the consequence is a splintering of the great trochanter.

3. In **Fracture of the Great Trochanter** the fragment is drawn upwards and backwards by the gluteal muscles, the obturator internus, the pyriformis, and the gemelli.

4. **Separation** of one or more of the three **epiphyses** in the upper end of the femur may occur. The **symptoms** of fracture of the neck of the femur may be explained as follows: (1) The **swelling** on the front of the joint immediately below Poupart's ligament is due to the interarticular effusion of blood or to the projection of the fragments. (2) **Shortening** of the limb is referable to the action of the glutei, hamstrings, tensor vaginæ femoris, rectus, sartorius, and ilio-psoas, and also the adductors, the gracilis, and the pectineus. (3) **Eversion** is caused (*a*) by the weight of the limb, which forces it to roll outwards, and (*b*) by the fact that the compact tissue on the posterior surface of the bone is more easily broken up than that on the anterior aspect; eversion follows as a consequence of the more extensive splintering of the posterior surface of the bone.

5. **Shaft.**—Fracture of this portion of the bone is

common in children, and in such subjects is usually tranverse. In adults an oblique fracture is the rule, occurring about the middle of the bone.

Table of Fractures of the Femur—Shaft and Lower End (Fig. 11).

Fracture.		*Displacement.*
1. Shaft:		
(*a*) In upper part below lesser trochanter	Upper fragment drawn	forwards and everted by ilio-psoas; outwards by external rotators and glutei.
	Lower fragment drawn	upwards behind upper fragment by rectus and ham-strings; inwards by adductors and pectineus.
(*b*) Through middle of shaft	Upper fragment	projects forwards for same reason as upper fragment in (*a*) does.
	Lower fragment	drawn inwards and upwards, behind upper fragment, by adductor fibres attached to it; rotated outwards by adductor magnus and weight of limb.
2. Lower End, in vicinity of condyles; transverse or T-shaped, into joint:		
In transverse fracture — the more common form of the two— ...	Upper fragment drawn	inwards by pectineus and adductors; forwards by psoas and iliacus.
	In many cases the fragment remains in its natural position.	
	Lower fragment drawn	backwards by gastrocnemius, plantaris and soleus.

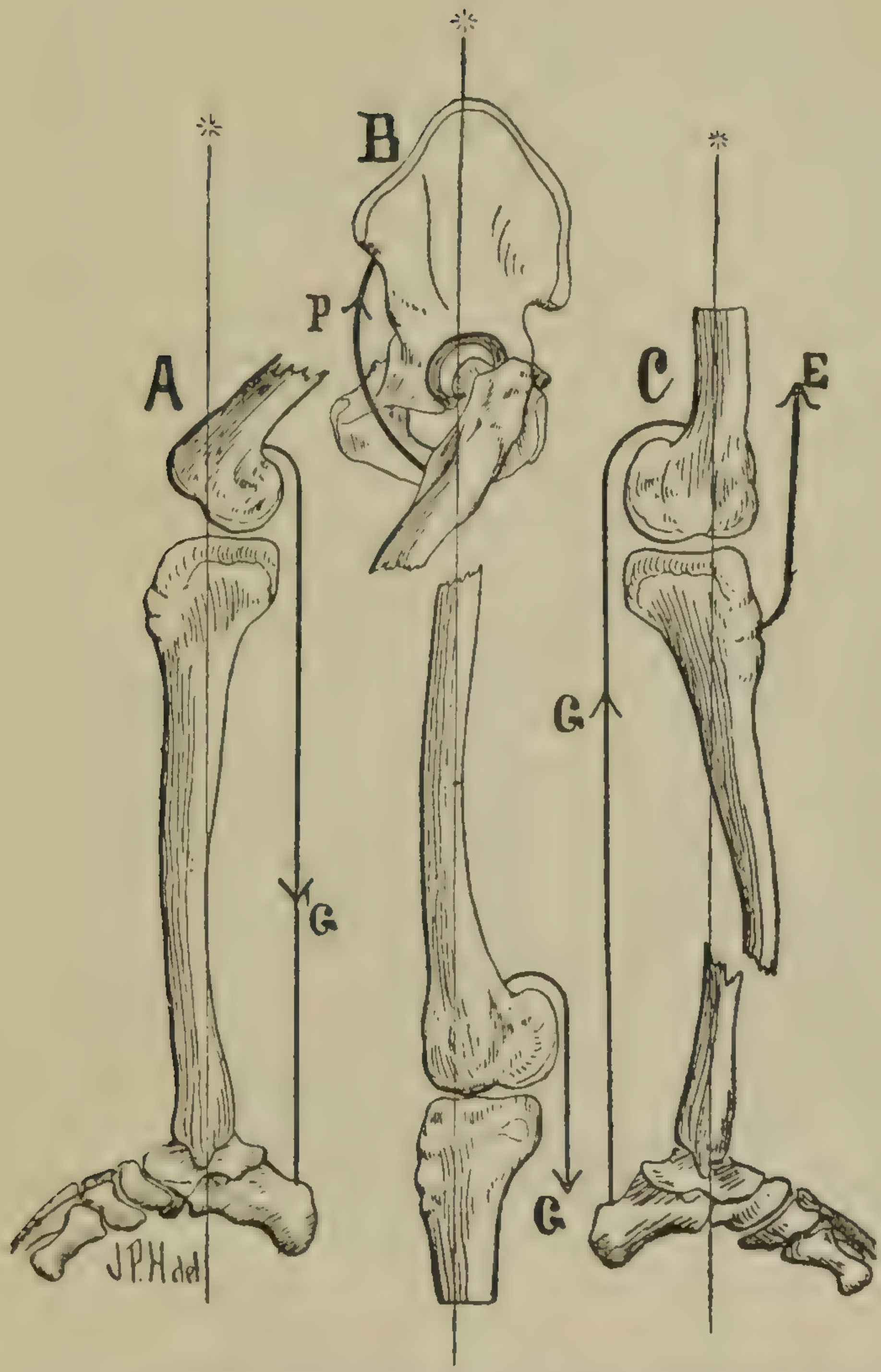

FIG. 11.—DIAGRAMS ILLUSTRATING DISPLACEMENTS OF THE FRAGMENTS IN FRACTURES OF THE FEMUR AND TIBIA (AFTER MCLACHLAN). * Normal line of limb. G. Action of gastrocnemius. P. Action of psoas and iliacus. E. Action of quadriceps extensor.

The Knee and Leg.

The **patella** lies almost completely above the condyles of the femur during extension; during flexion it corresponds to the intercondyloid notch, and rests mainly on the outer condyle. The inner border of the patella is in a line with the great toe; also, the apex of the patella, the ligamentum patellæ, the tubercle of the tibia, and the middle of the ankle-joint, are in a line with one another—these facts are of importance in relation to the adjustment of fractures. The **bursa patellæ** does not lie wholly on the patella, but partly on the lower portions of that bone, and partly on the upper portion of the **ligamentum patellæ**. Caution is necessary when excising the hypertrophied bursa, lest the capsule of the knee-joint be opened.

In thin persons the various bony points about the knee can be readily made out.

The **head of the fibula** is about 1 inch below the level of the knee-joint, and its upper extremity indicates the lower boundary of the synovial membrane. The **adductor tubercle** can be felt above the internal condyle of the femur—it gives attachment to the tendon of the adductor magnus, and corresponds with the level of the epiphysis of the lower end of the femur.

The line of the **popliteal artery** corresponds with the middle of the ham.

The **internal popliteal nerve** 'runs down the middle of the popliteal space, superficial and a little external to the artery, from which it is separated by the popliteal vein.' The **external popliteal nerve** lies in the outer part of the popliteal space, immediately to the inner side of the biceps tendon.

The Popliteal Space.

1. **Boundaries**—(1) *External Superior.*—The biceps.

(2) *Internal Superior.*—The semi-tendinosus, the semi-membranosus, and, more posteriorly, the gracilis and sartorius. The hamstring muscles, in certain neglected cases of disease of the knee-joint, are occasionally found **contracted.** The effect of this condition is not merely to flex the knee, but also to pull the tibia backwards. **Tenotomy** of one or more of the tendons (usually the

biceps) may be required to remedy the contraction. In performing the operation on the biceps tendon, avoid the external popliteal nerve and the external articular artery.

(3) *External Inferior.*—The outer head of the gastrocnemius and the plantaris.

(4) *Internal Inferior.* — The inner head of the gastrocnemius.

Roof.—Popliteal fascia. This structure is extremely dense, and influences the behaviour of **collections of pus** in the space. The tendency is for abscesses to pass in any direction, except straight backwards, through the fascia. Thus, the pus may pass up the thigh along the great sciatic nerve, or through the opening in the adductor magnus; it may ulcerate into the popliteal vessels or open into the joint, or it may pass down the leg along the great vessels and nerves.

Floor.—The popliteal surface (**trigone**) of the femur, the posterior ligament of the knee-joint, and the popliteus covered by its fascia.

The trigone is frequently the seat of **acute necrosis**. The cause of its frequency in this position is in all probability due to the fact that, in the young (the period of life, it will be remembered, at which acute necrosis is generally met with), the periosteum is but loosely attached to the bone, except, of course, at the points where muscles are inserted. The posterior ligament of the knee-joint, on the other hand, is very firmly connected with the femur; the result is that any movement putting severe strain on the ligament—such as hyperextension of the joint—would tend to cause it to tear away the loosely-attached periosteum from the trigone.

2. **Contents.**—(1) Small sciatic nerve. (2) Internal and external popliteal nerves and their branches. (3) Popliteal vessels with their branches and tributaries. These structures present several points of surgical interest:

(i.) The popliteal vessels are seldom wounded, owing to their deep situation.

(ii.) The artery has occasionally been ruptured by external violence; in a few cases, also, the vein has been ruptured in company with it; the latter vessel has probably never been ruptured alone.

(iii.) The popliteal artery is a common seat of

aneurism. This is accounted for by (*a*) the amount of movement, occasionally of a violent character, the artery is subjected to, and which may be of such a nature as to injure its two innermost coats; (*b*) the possibility of acute flexion of the artery, so that the blood is allowed to impinge with great force against its popliteal surface, which may subsequently bulge. Flexion, on the other hand, is practicable as a means of cure for popliteal aneurism, in conjunction with compression of the femoral artery.

(iv.) The relation of the artery to the vein explains the occurrence, in popliteal aneurism, of **coldness** and **œdema** of the leg, and, from the relation of the former vessel to the internal popliteal nerve, the 'rheumatic pains' and other symptoms of nerve pressure which are encountered.

(4) The space also contains the articular branch of the obturator nerve. (5) Fat and areolar tissue, a layer of which is interposed between the popliteal artery and the trigone of the femur; thus, **trigone necrosis** seldom ulcerates into that vessel. The artery, however, lies in close contact with the head of the tibia. (6) Four or five lymphatic glands are placed deeply along the vessels.

Bursæ in the Region of the Knee-joint.—Eight in number. (1) *In front*—(*a*) The bursa patellæ (*vide supra*). (*b*) A bursa between the ligamentum patellæ and the tubercle of the tibia. (2) *Behind: outer side*—(*a*) A bursa between the popliteal tendon and the tibia, a prolongation of the synovial membrane of the knee-joint. (*b*) A bursa between the popliteal tendon and the external lateral ligament. (*c*) A bursa between the biceps tendon and the external lateral ligament. (*d*) A bursa between the outer head and the gastrocnemius and the femur. *Inner side*—(*a*) A large bursa—**the popliteal bursa**—between the femur and the inner head of the gastrocnemius and tendon of the semi-membranosus, which often communicates with the joint. (*b*) A bursa between the semi-membranosus and the tibia.

The Knee-joint.

The **Knee-joint** (*vide* Fig. 12) is strong by reason of its powerful ligaments, hence the articulation is seldom **dislocated** as a result of traumatism. Certain sources

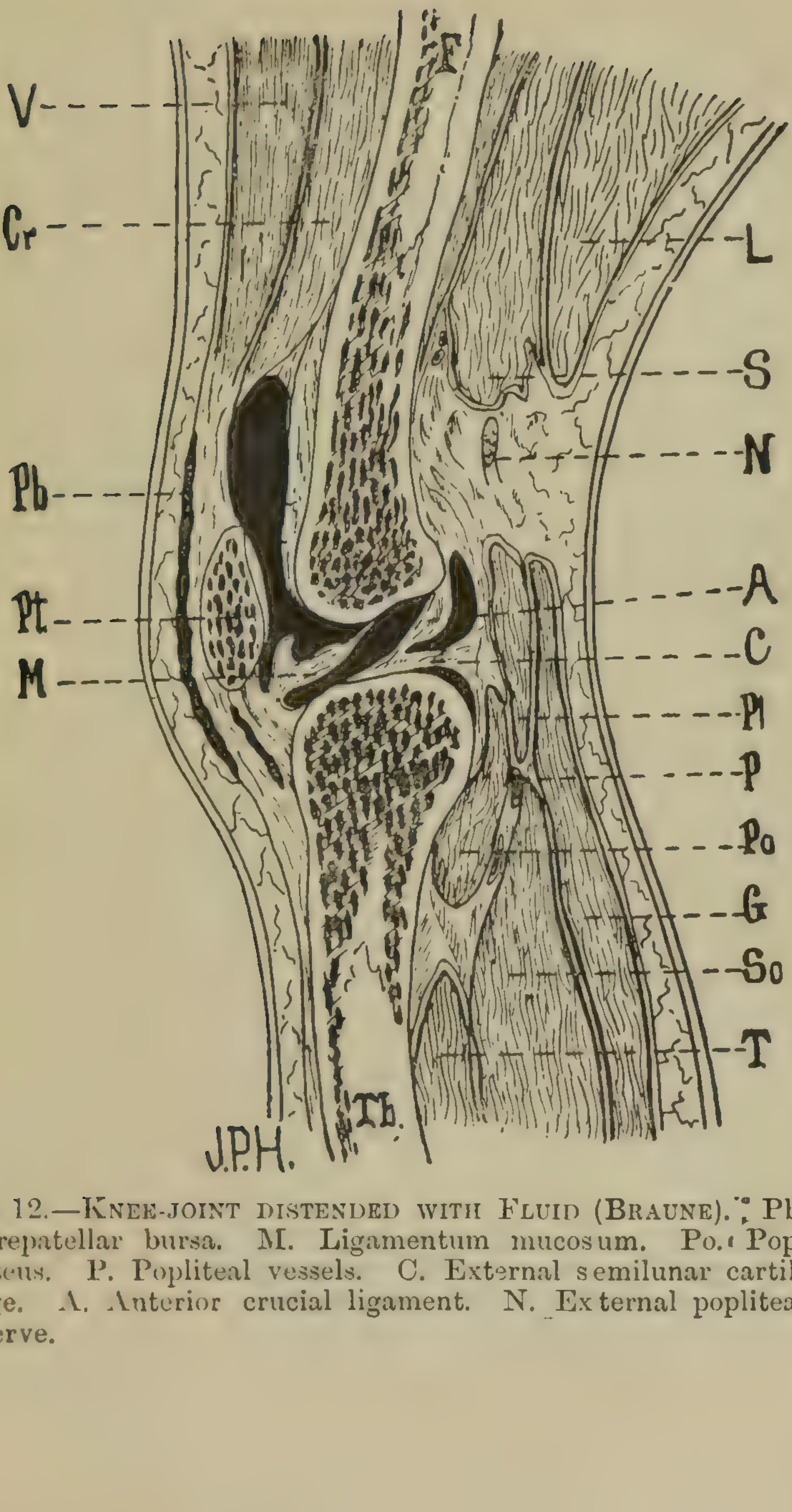

FIG. 12.—KNEE-JOINT DISTENDED WITH FLUID (BRAUNE). Pb. Prepatellar bursa. M. Ligamentum mucosum. Po. Popliteus. P. Popliteal vessels. C. External semilunar cartilage. A. Anterior crucial ligament. N. External popliteal nerve.

of weakness exist, which, however, do not come into play injuriously until the ligaments become softened by disease. These weak points are, the ill adaptation of the articular surfaces; the leverage capable of being brought to bear on the joint and (*c*) its free mobility; luxations are, therefore, not uncommon in some diseased conditions of the knee-joint. The tibia may be dislocated in various directions from the femur: forwards, backwards, inwards or outwards, or a combination of two of these may occur. Generally speaking, the antero-posterior dislocations are complete; the lateral (the more common), incomplete; but any luxation may be complete or partial.

The cause is, as a rule, direct violence applied to the tibia or femur, with, in many cases, a twisting of the femur superadded. In all these luxations the crucial ligaments are probably torn; in most the lateral ligaments are also ruptured; and in the antero-posterior displacements there is, in addition, rupture of the anterior part of the capsule, the posterior ligament, the gastrocnemius, biceps, and occasionally the semi-membranosus.

The **Synovial Membrane** of the knee-joint forms a large and complicated *cul-de-sac* beneath the extensor muscles of the thigh. The membrane

(1) **Reaches**, in the extended position, *above*, to about 2 inches above the upper border of the patella or trochlear surface of the femur. At the *sides* it passes beneath the vasti, extending higher on the inner than on the outer side; and *below* it extends to just above the level of the upper part of the fibular head. Above the sac there is sometimes a bursa which extends upwards for about a further inch, and frequently communicates with the synovial cavity.

(2) The membrane **covers** part of the lateral aspects of the tuberosities of the femur, both surfaces of the semilunar cartilages, and the inner surface of the capsule. Lastly,

(3) It sends **prolongations**, surrounding the popliteal tendon, around the crucial ligaments, and frequently into the superior tibio-fibular articulation.

The **Ligaments** limit the movements of the joint as follows: (1) Flexion is checked by the posterior crucial ligaments and the ligamentum patellæ. (2) Extension,

by the lateral and posterior ligaments and the anterior crucial; over-extension is checked by the posterior and posterior crucial ligaments. The two other movements permitted, in a limited degree, to the knee-joint when semiflexed are, (3) internal rotation, which is checked by the anterior crucial ligament, and (4) external rotation, which is checked by the posterior crucial ligament. Thus we see the immense importance of the crucial ligaments in fortifying the joint, since they alternately limit flexion and extension, and the posterior crucial over-extension. A heavy weight falling on the extended knee, with the leg supported by a chair, would probably cause rupture of this latter ligament. The crucial ligaments also prevent excessive rotation, and, lastly, they debar lateral movements of the joint from taking place; if therefore, in a given case of disease of the articulation lateral movement can be elicited, we may presume that the morbid process has advanced sufficiently far to destroy the crucial ligaments.

Subluxation of the knee is a partial dislocation of one of the semilunar cartilages, usually the **internal**. The accident is brought about by a twist of the leg when the knee is flexed. The cartilage may be displaced inwards into the intercondyloid notch, or outwards, so as to project beyond the articulating bones.

Acute synovitis of the knee (Fig. 12) is by no means an uncommon affection, owing to the exposed situation of the joint. The swelling is horseshoe in shape, rising 2 or 3 inches above the upper border of the patella, and extending higher on the inner than on the outer side, and is primarily apparent at the sides of the patella. The patella is floated up off the surface of the femur, and, by pressure applied firmly and suddenly to it (with the leg extended and the hip flexed), the knee-cap can be made to strike against the subjacent bone, conveying a peculiar impression to the surgeon's finger.

The position assumed by the joint is that of flexion, for the following reasons: (*a*) In this posture the joint holds most fluid; that is, holds the fluid with the least tension and pain; (*b*) the more powerful resistant ligaments (such as the posterior ligament, the posterior crucial and the lateral ligaments) are relaxed; and (*c*) the sensory nerves of the joint being disturbed, reflex

contraction of the muscles occurs, and the flexors having for various reasons the advantage of the extensors, flexion overpowers extension.

Strumous disease of the knee-joint is another common affection. Unlike the hip-joint, the process takes origin in the synovial membrane, because of the complex arrangement of the sac, its extensive lymphatic and vascular supply and the diffusion of injuries over the front of the joint —the soft parts thus bearing the brunt of the force— rather than to the ends of the bones.

Genu valgum is frequently encountered in children, and is induced by peculiar alterations in the pressure relations about the knee-joint. The pressure is low on the inner side, and high on the outer side, of the articulation ; as a consequence of this there is increased growth on the inner side, and slight atrophy, referable to the pressure, on the outer.

There are three steps in the process : (1) Tension and elongation of the ligaments and other tissues on the inner aspect of the joint ; (2) relaxation and subsequent contraction of the tissues on the outer side of the articulation ; (3) alterations in the bones — hypertrophy of the inner condyle and slight atrophy of the outer condyle. The shaft, and not the epiphysis, is responsible for the increased growth.

Patella—Fracture.—The patella is more frequently fractured by muscular action than any other bone in the body ; the quadriceps extensor contracts forcibly while the knee is semiflexed, and the consequence is that the patella snaps across the condyles—much as a stick does when broken across the knee — a transverse fracture resulting. The bone may also give way as the result of direct violence, as, for example, by a fall on the knee, in which case the fracture takes some form other than transverse.

The satisfactory treatment of this injury is a matter of some difficulty. The fragments are widely separated, and union occurs by fibrous tissue ; the result is that the patient is in many cases reminded of his accident by the stretching of this tissue leading to permanent lameness. Wiring the fragments, and innumerable other procedures, have been adopted in the treatment of the fracture.

Dislocation of the patella may occur outwards, inwards, or upon its edge, the inner edge looking forwards. The outward dislocation is the most common of the three, and is due to the fact that, in the extended position, the quadriceps extensor, the patella, and the ligamentum patellæ are not in the line of the tibia and femur, but are in a line lying outside the angle made by these bones; thus, it is apparent that the patella has more inducement to slip outwards than inwards in the position of extension—the most favourable for dislocation.

Excision of the knee-joint is best performed by a horseshoe incision from the back of one condyle to the back of the other, across the front of the joint just below the patella.

1. **Structures divided**: (1) Skin and fascia; (2) patellar, plexus of nerves, bursa and ligament; (3) anterior part of capsule of joint; (4) synovial membrane of joint; (5) lateral and crucial ligaments; (6) arteries: superior and inferior articular, anastomotica, and anterior tibial recurrent.

2. **Structures to be avoided**: (*a*) Internal saphenous vein and nerve; avoided by not carrying the incision too far back behind the inner condyle. (*b*) Popliteal artery; caution is especially indicated when sawing through the tibia. (*c*) Epiphyseal lines, in young subjects, of the femur (*vide supra*) and of the tibia. This latter is represented behind and at the sides by a horizontal line, which just marks off the tuberosities; in front the line slopes downwards, and encloses the tubercle of the tibia.

The Leg.

Vessels—1. **Arteries.**—The **Anterior Tibial** artery at first passes horizontally forwards, to reach the front of the interosseous membrane $1\frac{1}{4}$ inches below the head of the fibula. From this point onwards it lies in a *line* drawn from the front of the head of the fibula to the middle of the front of the ankle. The line corresponds approximately with the outer border of the tibialis anticus.

The **Posterior Tibial** artery commences $1\frac{1}{4}$ inches below the head of the fibula. It lies in a *line* drawn from the middle of the upper part of the calf to the hollow

behind the inner ankle, about ½ inch from the inner edge of the tibia.

It is to be noted that at the bifurcation of the popliteal artery **emboli** frequently lodge, with the result that gangrene of the leg ensues. From the contiguity of the vessels to the bone they are, when fracture occurs, liable to be injured by sharp fragments.

2. **Veins.**—The **Internal Saphena** vein arises from the inner part of the venous arch on the dorsum of the foot, passes over the front of the inner ankle, and extends up the inner side of the leg, knee, and thigh, to terminate in the femoral vein.

The **External Saphena** vein courses *behind* the outer ankle, and runs up the middle of the calf, to terminate (as a rule) in the popliteal vein.

The foregoing veins are very frequently **varicose.** Many causes conspire to produce this condition : (*a*) The great length of the veins which become involved, (*b*) the large columns of blood to be supported, (*c*) the fact that the veins are vertical in position, and (*d*) their superficial position, by which they lack the support which would otherwise be afforded by muscular action.

The two veins mentioned above are accompanied by sensory nerves; this is probably the principal cause of the pain felt when the veins are varicose.

Fractures of the Tibia and Fibula.—(1) As a rule, both bones fracture together, but exceptionally one may break, while the other remains intact. (2) The weakest part of the tibial shaft is in the region of its lower third ; the fibula, on the other hand, is least strong about its upper fourth. At these points respectively, therefore, the bones give way when **indirect** violence is applied to the limb, and the fracture is usually oblique. When the violence is **direct**, the breakage occurs at the point struck, and is generally transverse. (3) The **displacement** in fracture of one bone (Pott's fracture excepted), the other remaining unbroken, and the direction of the lesion transverse, will be practically nil. In oblique fracture of both bones, the **upper fragment** will be tilted forwards by the tendon of the quadriceps extensor, and rotated inwards by the sartorius, gracilis, and semi-tendinosus, this displacement being more marked when the tibia gives way in its upper part. The **lower**

fragment is drawn upwards and backwards by the muscles of the calf, and this deformity is more marked in fractures involving the lower parts of shafts of the tibia and fibula. The fragment is also rotated outwards by the weight of the foot (*vide* Fig. 11). (4) Fracture of the bones of the leg rarely occurs in children.

The Ankle and Foot.

Surface Anatomy.—The student is advised to make out the following landmarks on his own foot :

1. **Points of Bone.**—Along the **inner side of the foot,** beginning from behind, we can recognise (1) the tuberosity of the os calcis ; (2) the projection of the internal malleolus ; (3) the projection of the os calcis ('sustentaculum tali') about 1 inch below the malleolus ; (4) the tubercle of the scaphoid — the guide to the skin incision in Chopart's—1 inch in front of the internal malleolus and a little below : the gap between the scaphoid tubercle and the sustentaculum tali is filled by the calcaneo-scaphoid ligament and the tendon of the tibialis posticus ; (5) the internal cuneiform bone ; (6) the projection of the first metatarsal bone ; (7) the sesamoid bones of the great toe. Along the **outer side of the foot** we can recognise (1) the external tuberosity of the os calcis ; (2) the external malleolus ; (3) the peroneal tubercle of the os calcis (1 inch below the malleolus), with the long peroneal tendon below it and the short one above it ; (4) the projection of the fifth metatarsal bone.

2. **Lines of Joints.—Ankle :** Half an inch above the tip of the internal malleolus, to be remembered in connection with **Syme's** amputation.

Mid-tarsal : Compounded of the astragalo-scaphoid and calcaneo-cuboid articulations. The astragalo-scaphoid joint lies immediately behind the tubercle of the scaphoid, and a line drawn from just behind this process transversely across the foot will correspond with both the foregoing joints. The calcaneo-cuboid joint, if approached from the outer side of the foot, will be found to lie opposite a point midway between the outer malleolus and the base of the fifth metatarsal bone. Both the articulations above mentioned are opened in Chopart's operation.

Tarso-metatarsal articulation of great toe (*i.e.*, the joint between the internal cuneiform bone and the metatarsal bone of the great toe): This corresponds to a point $1\frac{1}{2}$ inches in front of the tubercle of the scaphoid. The projection of the fifth metatarsal bone is the guide to the joint between the cuboid and the fifth metatarsal bone; this projection and the preceding point ($1\frac{1}{2}$ inches in front of scaphoid tubercle) are the guides for **Lisfranc's** operation, in which the anterior part of the foot is removed.

The **metatarso-phalangeal** joint-lines lie one inch farther back than the interdigital folds of skin—to be remembered in **amputation of the toes.**

Fascia about the Ankle.—The **Anterior Annular Ligament** is divided into two parts—an upper, transverse, in front of the tibia and fibula, and a lower oblique portion, extending on to the tarsus. Passing beneath the ligament are the tendons (from within outwards) of the tibialis anticus, extensor proprius hallucis, extensor longus digitorum, and peroneus tertius; also the anterior tibial vessels and nerves, lying external to the tibialis anticus. Beneath the upper portion is a single synovial sheath, that for the tibialis anticus; beneath the lower are three sheaths, the extensor longus digitorum and peroneus tertius sharing one in common, while of the remaining tendons each occupies a separate sheath.

The **Internal Annular Ligament** extends from the inner malleolus to the inner tuberosity of the os calcis. Passing beneath this ligament are the tendons of the tibialis posticus (lying immediately behind the internal malleolus); then, in succession, that of the flexor longus digitorum, the posterior tibial vessels and nerve, and the tendon of the flexor longus hallucis.

The **External Annular Ligament** extends from the external malleolus to the outer surface of the os calcis. Passing beneath it are the tendons of the flexors brevis and longus, the brevis being in front; they have a common synovial sheath.

The sheaths of the tendons passing beneath the external and internal annular ligaments extend about $1\frac{1}{2}$ inches above the malleoli; therefore, in **tenotomy**, keep clear of them by cutting the tendons 2 inches above the malleoli.

The **Plantar Fascia** is divided into three portions:

(*a*) A central portion, strong, thick, and unyielding. It helps to preserve the arch of the foot very much on the same principle as a bowstring maintains the arch of the bow, and a relaxation of the fascia allows the arch of the foot to sink, **flat-foot** resulting. On the other hand, if contracted, the pedal arch is increased; thus, in **talipes cavus** the deformity—a marked hollowing of the sole of the foot—depends mainly on contraction of this fascia. The most favourable spot at which to divide the fascia, if necessary, would be about 1 inch in front of its insertion into the os calcis; the knife should be introduced from the inner side. On account of the unyielding character of the membrane, an **abscess** will tend to point anywhere rather than in the centre of the sole. Such abscesses cause intense pain, and occasionally effect great destruction of tissue. (*b*) The two outer portions of the fascia are thin, although the outer is somewhat the thicker of the two, and is contracted in some forms of club-foot.

The only **Bursæ** of any importance in the region of the foot are: (1) A bursa between the tendo Achillis and the os calcis. The structure rises $\frac{1}{2}$ inch above the os calcis, and bulges on either side of the tendon; a suspicion of ankle-joint disease may be excited when the bursa is inflamed. (2) A bursa over the metatarso-phalangeal joint of the great toe, which may become enlarged and constitute **bunion.** The cause of this deformity is a forcing of the great toe obliquely outwards, so that it does not lie parallel to the axis of the foot, as it should normally. The consequence of this is that the toe and adjacent parts of the foot suffer considerable loss of power, the internal lateral ligament of the joint becomes lengthened, and the tendon of the extensor proprius hallucis displaced outwards. Improperly shaped boots are responsible for this deformity.

The **Tendons** about the foot are occasionally **ruptured** from violence, more especially the tendo Achillis, which usually breaks about $1\frac{1}{2}$ inches above its insertion, as the structure is here somewhat more slender. The surgeon not infrequently encounters cases in which a tendon has been wrenched from its connections and **displaced.** The most commonly displaced tendon is that of the peroneus longus.

One or other of the tendons of the foot frequently

requires **division** in club-foot. The tendo Achillis is usually cut 1½ inches above its insertion, and the knife should be introduced from the inner side to avoid the posterior tibial vessels. The tibialis posticus tendon is usually divided just above the base of the internal malleolus. The tendon of the tibialis anticus is divided either in front of the ankle or at its insertion into the internal cuneiform bone. The peroneal tendons should be divided by introducing the knife perpendicularly to the surface, and about 2 inches above the apex of the external malleolus, to avoid the synovial sheaths.

Arteries of the Foot.—The **external plantar** artery is in a *line* drawn obliquely across the sole from the hollow behind the inner ankle nearly to the base of the fifth metatarsal bone. From this point the artery turns across the foot, lying (deeply) near the bases of the metatarsal bones, to anastomose with the dorsal artery, and thus form the plantar arch.

The **internal plantar** artery is in a *line* drawn from the inner side of the os calcis to the middle of the great toe. The **dorsalis pedis** artery extends from midway between the malleoli to the back part of the first interosseous space. The vessel is in close relation to the tarsal bones, and hence has been ruptured in severe contusions of the foot, and may be divided in wounds of the dorsum of that member.

Wounds of the plantar arch are serious mainly because of the depth at which it lies, giving rise to difficulty in ligaturing the vessels. Ligature of both the anterior and posterior tibial vessels would not necessarily arrest hæmorrhage from the arch, on account of an indirect communication which it effects with the peroneal artery. It is found, however, as a matter of practice, that elevation of the limb and pressure on the bleeding-point and on the main vessels are usually sufficient measures to check the bleeding.

The **Ankle-joint** is strong, not only by reason of the excellent coaptation of its bony surfaces, but also on account of its powerful ligaments.

The **Ligaments** of the articulation are: (1) Anterior and (2) posterior, which are both very thin; (3) internal lateral, or deltoid, and (4) external lateral, which consists of three strong fasciculi; (3) and (4) are strong ligaments.

In **acute synovitis** the swelling appears principally at the front of the joint, beneath the anterior tendons, and on either side, between the tibialis anticus and internal lateral ligament on the inner side, and between the peroneus tertius and external lateral ligament on the outer side. Occasionally the hollow on either side of the tendo Achillis becomes filled up.

Club-foot.—There are four varieties of this deformity: (1) Talipes varus—usually talipes equino-varus, as it is rarely quite pure; (2) talipes equinus; (3) talipes valgus; (4) talipes calcaneus.

(1) **Talipes varus** is frequently congenital, and when that is the case is often found to be double, and associated with spina bifida.

Changes Produced (in talipes equino varus).—(*a*) The heel is raised and the toe pointed; (*b*) the foot is inverted and adducted; (*c*) contraction takes place of all the tissues on the inner side of the sole, from constant pressure preventing growth; (*d*) elongation of all the tissues, on the outer side of the sole, from too little pressure.

Structures Divided.—Tibialis anticus and posticus, and, if necessary, tendo Achillis and plantar fascia. In some cases it may be necessary to remove wedges from one or more bones of the foot, or to excise the astragalus.

(2) **Talipes Equinus.**—In this form the heel alone is raised. It is the commonest acquired form.

Changes Produced.—(*a*) The tendo Achillis is contracted, raising the os calcis; (*b*) the first phalanges are subluxated on the heads of the metatarsal bones, and these latter structures are flexed and depressed into the sole of the foot; the result is that, like the cat and other digitigrade carnivora, the patient walks on the heads of the metatarsal bones; (*c*) the astragalus is forced downwards, and appears on the dorsum of the foot; (*d*) the structures of the sole are contracted.

(3) **Talipes valgus** is a condition in which the outer border of the foot is raised; this is preceded by an obliteration of the arch of the foot—'flat-foot'—so that the sole becomes perfectly level.

Changes Produced.—The foot presents two arches, a transverse and an antero-posterior. The first lesion is a relaxation which occurs in the ligaments and other

structures supporting the arches. (*a*) Those supporting the **transverse** arch are principally the interosseous ligaments between the cuneiform and cuboid bones. (*b*) Those supporting the **antero-posterior** arch are, the long and short plantar ligaments; the **inferior calcaneo-scaphoid ligament**, which supports the head of the astragalus, and is the ligament chiefly concerned in the production of the deformity; the plantar fascia; the tendon of the tibialis posticus, and the tonic contraction of the muscles of the sole. These structures, then, give way, and the second lesion occurs, which is a drawing up of the outer side of the foot.

Flat-foot is frequently associated with a peculiar straight and rigid condition of the great toe—**hallux rigidus.**

Structures Divided.—The peroneal tendons may be divided, but tenotomy is seldom necessary. 'Forcible over-rectification' has been adopted with success, especially in cases of rigid flat-foot. The foot is wrenched into a position of extension and adduction, and confined there by plaster-of-Paris bandages. In very severe cases a bony wedge, composed of the scaphoid and part of the astragalus, may be removed from the inner side of the foot (Schwartz).

(4) **Talipes Calcaneus.**—In this condition the toes are raised by the extensors, and the patient walks upon his heel; in addition to this, in acquired cases, the anterior part of the foot droops.

Various orthopædic appliances have been devised with the object of treating this condition; operative measures do not appear to be satisfactory.

Dislocations of the Ankle — *Outwards* (**Pott's Fracture**).—This luxation is the most common of the series. The fibula is broken from 1 to 3 inches above the malleolus; the internal lateral ligament is torn, or the internal malleolus wrenched off; the foot is greatly everted, owing to the rotation outwards of the astragalus, and the heel is drawn up by the muscles of the calf. This form of the outward dislocation is an incomplete one. There is also a complete form occurring with much greater rarity, and with which **Dupuytren's fracture** is synonymous. In this injury the fibula is broken from 1 to 3 inches above the malleolus. Unlike Pott's fracture,

there is very little eversion of the foot, the dislocation of the ankle is complete—the astragalus lying with the fractured malleolus completely to the outer side of the bones of the leg—the strong inferior tibio-fibular ligaments are ruptured, or the portion of tibia to which it is attached is torn off, and there is shortening of the leg from drawing up of the astragalus and foot.

Inwards.—The external lateral ligament is torn, or the tip of the outer malleolus wrenched away. As a rule, it will be found that the inner malleolus is broken. The astragalus rotates on its antero-posterior axis in such a manner as to produce inversion of the foot, and the inner border of the foot is raised.

Backwards.—If this luxation be complete, the anterior and posterior ligaments are torn, and a considerable portion of each lateral ligament; the astragalus is displaced behind the tibia, and the lower articulation of the latter bone finds a resting-place on the astragalus and scaphoid. The fibula gives way, and sometimes the tibia also.

Forwards.—Very rare, and probably always incomplete.

Upwards.—Also rare. The tibia and fibula are separated, the inferior tibio-fibular ligaments are torn, and the astragalus is forced upwards between the two bones; the anterior and posterior ligaments are ruptured.

As regards the **causation** of the above fractures, it is found that they are usually brought about by a violent and sudden twist of the foot. The antero-posterior are likely to occur when the foot is suddenly arrested during a violent impulse of the body, as in jumping from a carriage in motion.

The **Synovial Membranes** of the foot are seven in number: (1) One for the ankle-joint; (2) one for the posterior calcaneo-astragaloid joint; (3) one for the anterior calcaneo-astragaloid and astragalo-scaphoid joints; (4) one between the os calcis and the cuboid; (5) one between the cuboid and the two outer metatarsal bones; (6) one between the internal cuneiform and first metatarsal bones; and (7) one for the remaining articulations.

The **Tarsal Bones** are not commonly fractured, although the foot is a member peculiarly liable to injury. The former fortunate circumstance is due in a large measure to the numerous articulations of the foot and

the strong ligaments surrounding these joints, by which the force is broken up ; but when fracture does occur the injury is a serious one, as it is frequently compound and comminuted, and amputation is often necessary.

If, in a given case of injury, fracture is discovered in the anterior group of tarsal bones, the surgeon may usually come to the conclusion that the antecedent violence was **direct** ; a fracture, on the other hand, occurring in the posterior group of tarsal bones is frequently due to a form of **indirect** violence, such as a fall from a height on the feet. The seat of fracture in the os calcis is in the portion behind the articular surface ;

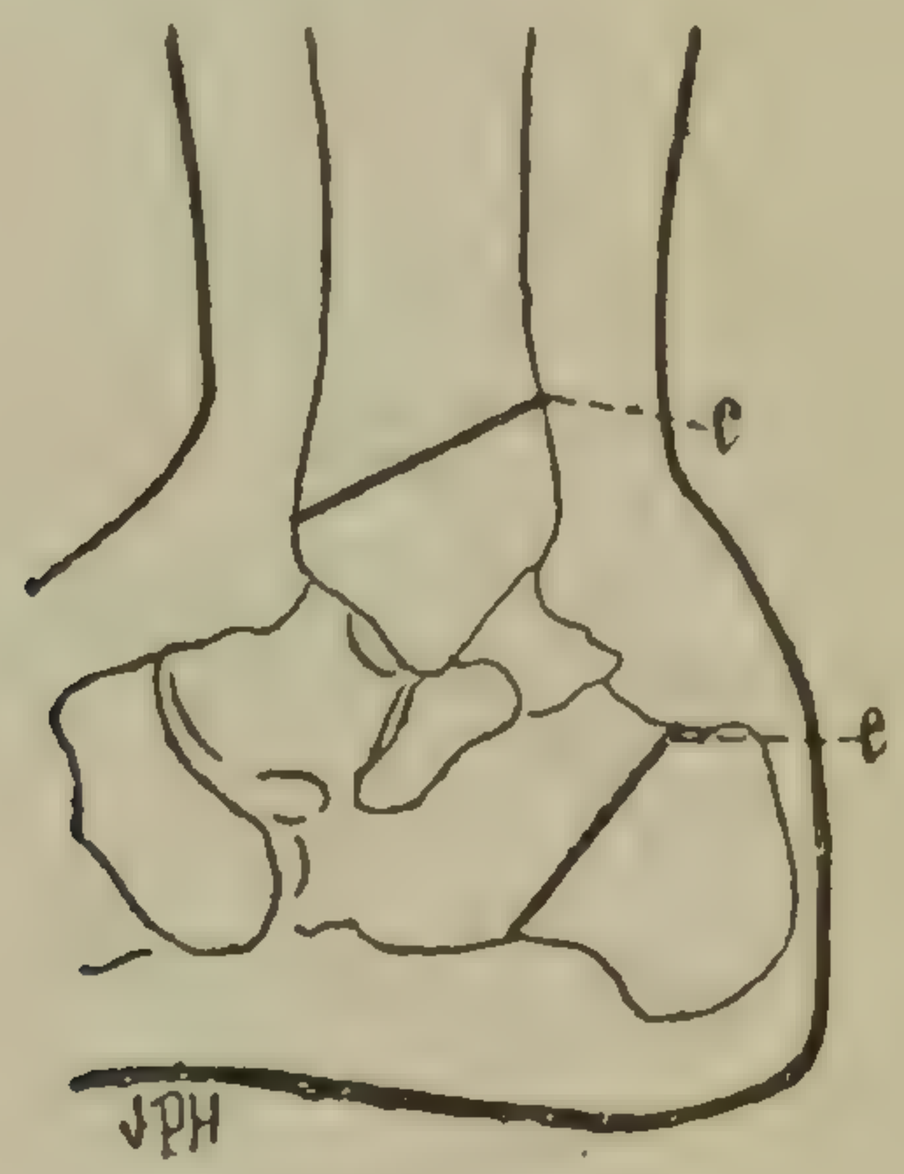

FIG. 13.—SAW-CUTS IN PIROGOFF'S OPERATION, SHOWN BY LINES CC. (AFTER TREVES).

in the astragalus the neck, which is the weakest part of the bone, gives way.

The tarsal bones are very often the seat of **tubercular caries**, due to (*a*) the fact that the bones are composed of delicate cancellous tissue, and that the synovial membranes are of a complex character ; (*b*) the fact that the circulation is, in the foot, comparatively feeble, and the blood-supply on thinly-covered parts, such as the dorsum, scanty ; (*c*) the unrestful condition of the foot.

If caries attack the os calcis or astragalus, it confines its attentions to the individual bone for a considerable

period, but when any of the other tarsal bones are the seat of disease, the morbid process usually spreads rapidly to the remaining components of the tarsus by means of the complicated synovial membrane, which is more or less common to these bones.

Any of the foregoing bones may require removal indi-

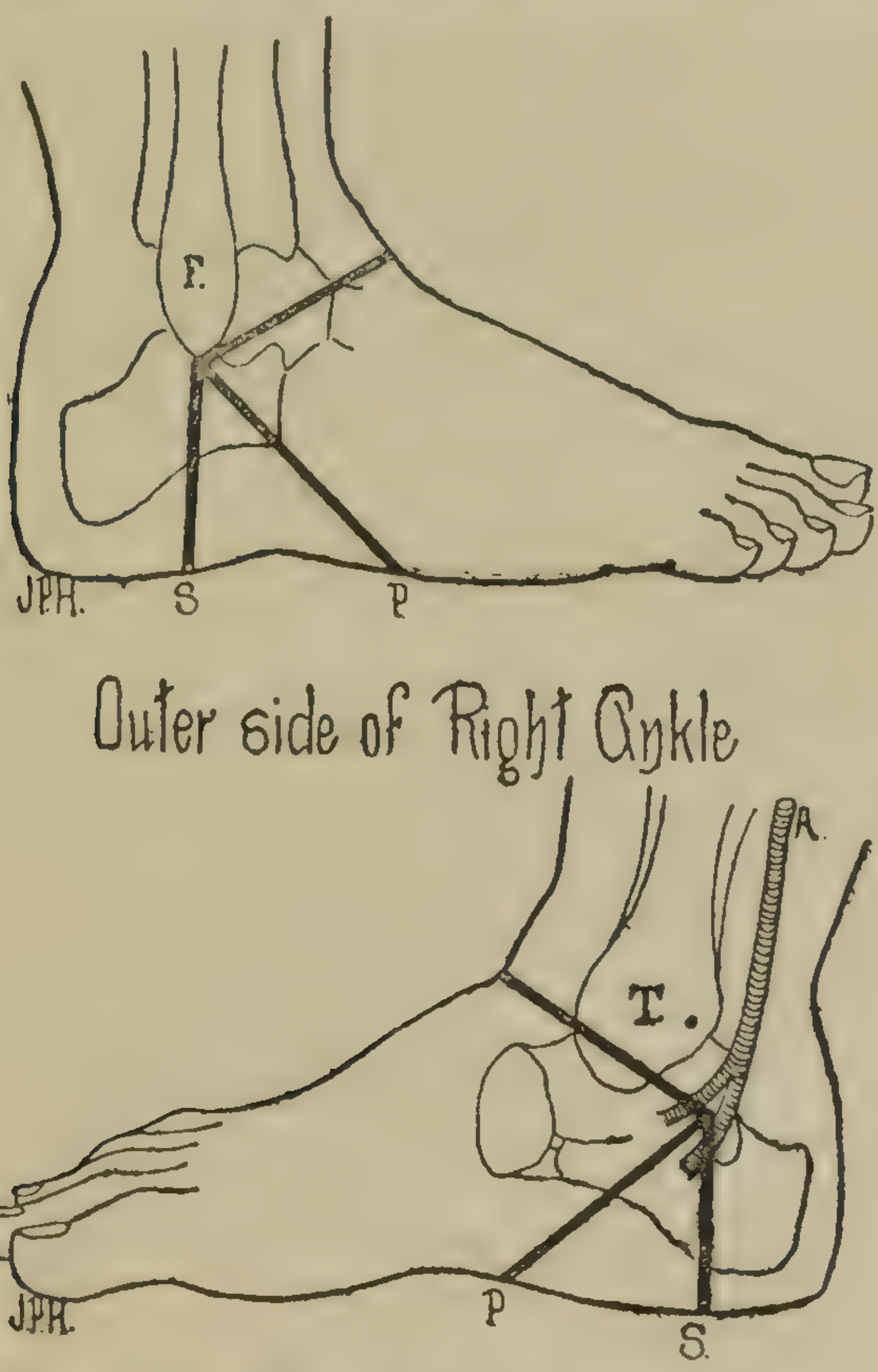

FIG. 14.—LINES OF INCISION IN PIROGOFF'S (P) AND IN SYME'S (S) AMPUTATIONS (AFTER MCLACHLAN.) A. Posterior tibial artery.

vidually, more especially when the disease is limited to one only. Wedge-shaped pieces of the tarsus, as has

been mentioned above, may occasionally be removed with benefit in severe cases of club-foot.

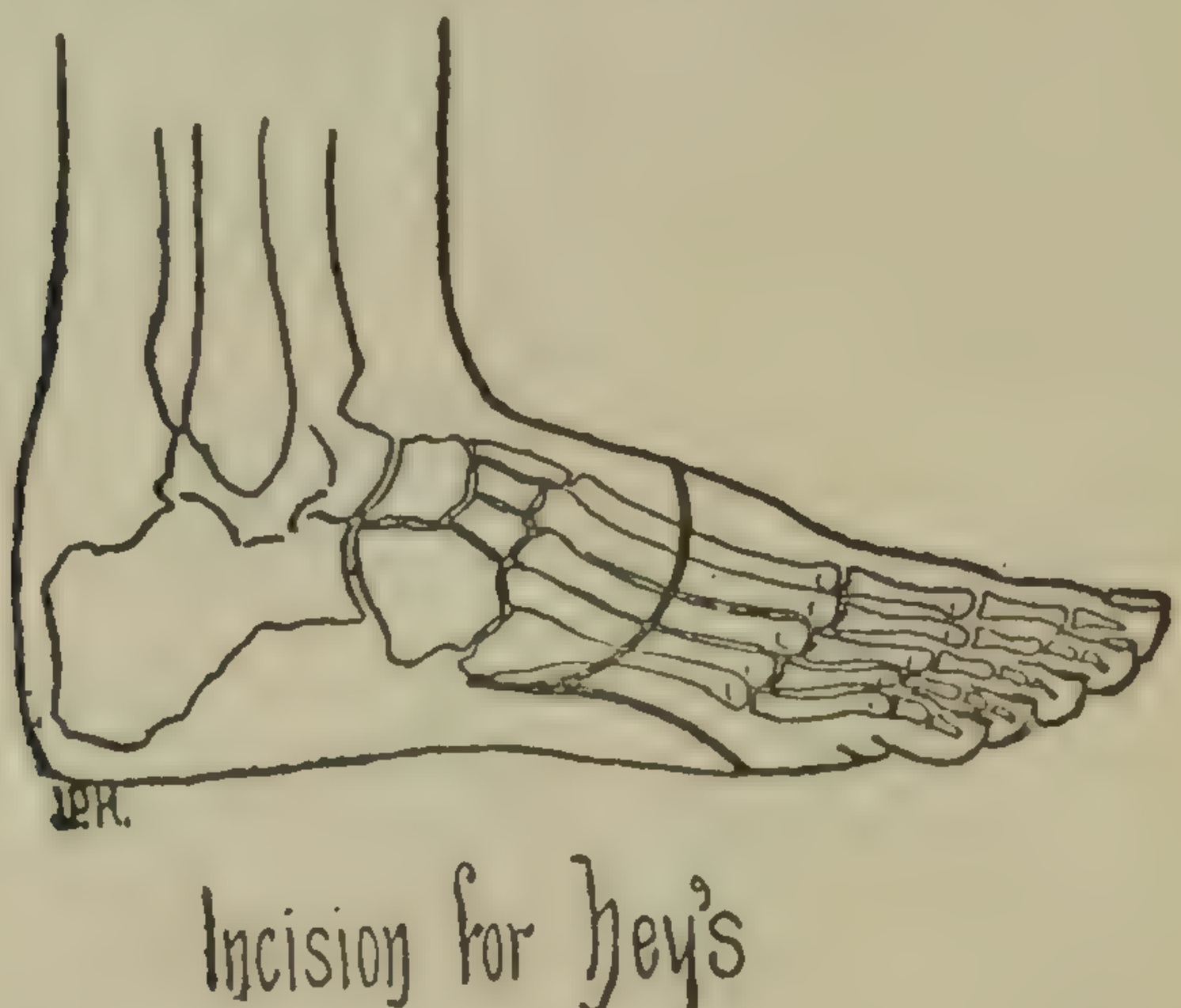

FIG. 15.—LINES OF INCISION IN HEY'S AND CHOPART'S AMPUTATIONS (AFTER McLACHLAN).

Amputations of the Foot.—The principal amputations are : (1) **Syme's** (*vide* Fig. 14).—This amputation consists in the removal of the foot at the ankle-joint by

a heel flap, the malleoli being taken away. Occasionally the operation is modified by the removal, in addition to the malleoli, of a thin slice from the lower end of the tibia.

(2) **Pirogoff's** (*vide* Figs. 13 and 14).—All the tarsal bones in this operation are removed except the posterior part of the os calcis. A thin slice is taken off the lower ends of the tibia and fibula—including the malleoli—and the sawn surface of the os calcis is turned up and united to the similar surface on the tibia.

(3) **Subastragaloid Amputation.**—In this all the tarsal bones are excised except the astragalus, the foot being removed below that bone at the calcaneo-astragaloid articulation.

(4) **Chopart's** (*vide* Fig. 15), or Medio-tarsal Amputation.—All the tarsal bones are removed except the astragalus and os calcis, and disarticulation is effected between the astragalus and scaphoid on the inner side, and the os calcis and cuboid on the outer side.

(5) **Lisfranc's.**—In this procedure the anterior part of the foot is amputated at the tarso-metatarsal joints. The operation has been modified :

(*a*) By **Hey** (*vide* Fig. 15), who sawed off a bit of the **tarsus**—the projecting portion of the internal cuneiform bone—and disarticulated the others.

(*b*) By **Skey**, who sawed off a portion of the metatarsus—the projecting base of the second metatarsal bone—and disarticulated the others.

Table showing the Principal Structures divided in the Chief Amputations about the Foot.

	Integument.	*Muscles.*	*Vessels.*	*Nerves.*	*Ligaments.*	*Bones.*
Lisfranc's, Chopart's, Hey's.	Integument and plantar fascia.	Tibialis anticus and extensor brevis digitorum. Extensor communis and peroneus tertius. Extensor proprius hallucis. Peroneus longus and brevis. Tibialis posticus. First, second, and most of third layer of muscles of sole. In *Hey's* the tibialis anticus and posticus and flexor accessorius are not divided.	Internal plantar artery. External plantar artery, with plantar arch and digital branches. Dorsal artery and some of its branches.	Anterior tibial *or* branches. Plantar nerves. Musculo-cutaneous *or* peroneal (digital branches). External saphenous (digital branch).	(*a*) Of the various joints opened into. (*b*) Long and short plantar and inferior calcaneo-scaphoid.	Part of internal cuneiform (in *Hey's*).
Suba-tragaloid, Pirogoff's, Syme's.	Integument and plantar fascia.	Same as above, except: (*a*) Tendo Achillis and plantaris divided in addition; (*b*) Part only of second, and *none* of third, layer of sole muscles divided.	Dorsal artery *or* anterior tibial. Internal and external plantar arteries *or* posterior tibial, close to bifurcation. Long and short saphena veins. Branch of peroneal artery =external calcaneal. Branch of external plantar =internal calcaneal. Various small twigs.	Posterior tibial *or* plantar nerves. Anterior tibial. Musculo-cutaneous *or* peroneal. Long and short saphenous.	Of all the various joints opened into.	*In Pirogoff's and Syme's*, ends of tibia and fibula. *In Pirogoff's*, the os calcis. *In Subastragaloid*, none of the above bones, but usually the head of the astragalus.

In Pirogoff's.

1. Tendo Achillis not divided.
2. Flexor brevis digiti, abductor pollicis, and abductor minimi digiti divided extensively.
3. Plantar vessels cut farther from bifurcation.
4. Os calcis sawn.

In Syme's.

1. Tendo Achillis divided.
2. These muscles divided less extensively.
3. Plantar vessels cut nearer bifurcation.
4. Os calcis not sawn.

CHAPTER VII.

THE SPINE.

Curves. — The spine has normally four curves—viz., convex forwards in the cervical and lumbar regions, and convex backwards in the dorsal and sacral regions. At birth the spine has one curve, with its convexity backwards. In **kyphosis** the antero-posterior curvature, usually in the lower cervical and upper dorsal regions, is exaggerated, and the convexity is backwards. In **lordosis** the part affected is, as a rule, the lumbar region, and the convexity is forwards. In **scoliosis** the spine presents two curves—a primary and a compensatory curve. In the form commonly met with, the convexity is towards the right in the dorsal region, and towards the left in the lumbar region.

Fracture-Dislocation. — Inasmuch as the danger of fracture and dislocation of the spinal column depends to a great extent on the damage done to the cord, it is obviously of importance that the bony column should be constructed in such a manner as to minimize the effect of shocks applied to it. The spinal cord is protected from injury by (*a*) the construction of the column in a number of pieces, with but slight movement between the segments, and, on the other hand, a fair range of movement in the whole; thus a certain amount of flexibility is ensured, so that the column must bend before it breaks. The number of joints has the disadvantage of rendering the spine liable to **sprains**, but these are rarely severe. (*b*) The disposition of the spine in curves. In this way the four natural curves alluded to above, break up what would otherwise be a long column into a series of short columns, and short columns break less readily than a long

column of the same calibre and material. (*c*) The presence of the elastic intervertebral discs, which act as buffers. (*d*) The wide size of the canal, and the central position and small size of the cord. (*e*) The gap left between the membranes and the bone. (*f*) The slinging of the cord by the ligamentum denticulatum in the centre of a canal of fluid.

Fracture and dislocation of the spinal column usually occur concurrently. Fracture may occur without dislocation, but very rarely dislocation without fracture.

The **causes** of fracture-dislocation may be (1) indirect violence, as by a 'header' into shallow water; (2) direct violence; and (3) a mixture of direct and indirect violence, as in the case of a man who, falling from a height, alights on his back on a bar, and is then doubled over it.

Parts Injured.—Those most liable to injury are (1) the **dorsi-lumbar region**, because, being near the centre of the column, great leverage is capable of being brought to bear on it, and, further, the portion above is comparatively fixed, and the vertebræ which compose it, though considerably smaller, have nevertheless to bear almost as much weight as those below; (2) the **cervico-dorsal region**, because here the flexible cervical portion joins the more fixed dorsal portion; (3) the **atlo-axoid region**, because it is permitted a free range of movement, and is liable to be affected by violence applied to the head. The **results** of fracture-dislocation depend on the position of the injury.

(1) In dislocation of the atlas from the axis, or in fracture of the odontoid process, the patient will die at once from injury to the medulla.

(2) In fracture-dislocation above the fourth cervical vertebra—*i.e.*, above the origin of the phrenic nerves—the patient dies in a few minutes.

(3) Just below this point, as between the fifth and sixth vertebræ, the patient may possibly live a few days, but with everything below the injured point paralyzed—arm, leg, abdominal muscles, bladder, and bowel, etc.; the breathing is entirely diaphragmatic, and the patient gradually dies comatose.

(4) In the lower dorsal region, with careful nursing, the prognosis is fairly good. If the patient survive the

spinal injury, there is usually some disturbance of micturition and defecation.

Micturition is affected as follows : If the centre in the lumbar enlargement be damaged, there is, in the first place, a short period of retention, and then absolute incontinence.

If the cord be damaged higher up there is, immediately after the accident, retention, from a temporary suspension of reflex action, due to shock. At a later date reflex action reasserts itself ; but the centre being cut off from the inhibitory influence of the brain, the bladder empties itself at frequent intervals without reference to the patient's will.

Defecation is disturbed as follows : If the centre be damaged, there will be incontinence of fæces as a result. If the cord be damaged higher up, there will be regular acts of defecation without the knowledge or will of the patient.

The Spinal Cord in the adult extends from the foramen magnum to the first lumbar vertebra. In the new-born infant the cord extends as far as the third lumbar vertebra, and in the fœtus cord and canal are the same length. The spinal dura mater not being so intimately connected to the adjacent bones as the cranial dura mater is, **spinal meningitis** after injuries to the bones is not such a common sequel as cerebral meningitis after injuries of the cranial bones.

In the cervical region the cord and its membranes may be injured by a punctured wound, and, moreover, between the occiput and the atlas, not only may the cord be wounded by a stab, but the vertebral artery may suffer division. In the dorsal region the laminæ overlap each other, and thus protect the cord more effectually.

INDEX.

Baillière, Tindall & Cox, 20 and 21, King William Street, Strand.